A STUDY OF THE LEAF-MINING DIPTERA OF NORTH AMERICA

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A THESIS

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF CORNELL UNIVERSITY FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

BY

STUART WARD FROST

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A STUDY OF THE LEAF-MINING DIPTERA OF NORTH AMERICA[1]

S. W. Frost

Leaf-miners are abundant everywhere — in the field, by the roadsides, along streams, and even within the leaves of aquatic plants. Their abundance and interesting habits have long been recognized and associated with four orders of insects: Lepidoptera, Diptera, Coleoptera, and Hymenoptera. Of these four orders, the Diptera have been studied the least. It is the purpose of the author to bring together here, for the first time, the many scattered notes on the various species of dipterous leaf-miners, and to summarize the work of several years, in both the field and the laboratory, on their life histories and habits.

In this study the European species have been considered, for three reasons. First, because several species, genera, and families are thereby added to the list of leaf-miners, thus making more valuable the comparative study of the mining habit. Secondly, because numerous synonyms of European species occur in American literature. (Stein, Malloch, and Melander have done much, in their respective groups, to straighten out the synonymy, and in many cases the American species have been found to be identical with the European forms. Further attempts are made in this study to determine the true identity of the American species.) Thirdly, because several doubtful leaf-mining species, such as *Coenosia bilinella* Zett., should be included, chiefly for their historic value.

The scope and importance of the dipterous leaf-miners is not generally recognized. It has been obscured by the abundance and prevalence of the lepidopterous leaf-miners. However, the Diptera are represented by six leaf-mining families and eleven leaf-mining genera in North America, and a number of these genera are entirely of the mining habit. As far as the writer knows, the genera Agromyza and Phytomyza are composed wholly of miners in roots, stems, and leaves of plants. All the known species of Phytomyza mine the leaves. The species of Pegomyia are chiefly miners of plants, although a few have other habits. The importance of the leaf-miners is recognized chiefly through several injurious forms, such as the beet leaf-miner, the chrysanthemum leaf-miner, and the box-elder leaf-miner.

[1] Contribution from the Department of Entomology of the New York State College of Agriculture at Cornell University, Ithaca, New York.

GENERAL CONSIDERATIONS

MANNER OF CONDUCTING THE INVESTIGATION

In making this study, the literature on the subject was first examined carefully in order to determine the families, the genera, and the species of Diptera that have been recorded as leaf-miners, and the plants from which they have been reared. In the past, carelessness in rearing work has led to many errors, such as the record of *Stomoxys calcitrans* as a miner of Solanum, which appears in Glover's notes (1874). Such a mistake is obvious. Other errors, however, are not so easily discovered, and the more doubtful species are therefore included in this study in order to make the list complete.

Several summers were devoted to rearing work. The abundance of the host plants necessitated special efforts in the collection and identification of a large number of plants, and the rearing of a comparatively few species of flies from the many hosts. Special stress was placed on the family Anthomyiidae, and the life histories of the more important American species were worked out in detail. In the other families and genera, notes were taken on the distribution, the host plants, the habits, and the types of mines, of the different species.

The distribution records were compiled from literature, from the examination of many collections, and from records contributed by various collectors and by museums. The host-plant records were likewise obtained from literature and from abundant material reared during the course of this study. A few records were obtained from individual collectors. It is not possible always to vouch for the validity of records obtained from literature. Often species have been too hastily determined or identified by persons who are unfamiliar with the group. While an attempt has been made to ascertain whether the species recorded in literature have been correctly determined, still some mistakes are unavoidable. In order to facilitate reference to these records, the authority and the date for the first published record of each food plant, for each species, are given. The omission of a date indicates that the record has not been published.

COLLECTING METHODS ADAPTED FOR LEAF-MINERS

Insects are usually collected for systematic study, but for this work they were collected for rearing purposes also. This required a system of obtaining live material, with a record of the proper host, the date, and the locality, and involved some modifications of the ordinary collecting methods.

Two systems were employed, both of which proved satisfactory. Round, seamless, tin boxes were used at first, a separate box being used for each host plant and for each of the different types of mines found

on the same host plant. The proper records were placed in the respective boxes. As a rule, the leaves remained fresh in the boxes until the larvae had transformed. While this method worked well, it required a large number of boxes, and there is a limit to the number of such boxes that one can conveniently carry. This handicap suggested another and a more compact method. The leaves containing the miners were folded in tissue-paper triangles, much as a lepidopterist wraps his duplicate material. These small packages were then placed in a tin box. The box retained enough moisture to prevent the leaves from drying out, and leaves from many different plants could be placed in the same box without confusing the records. If the larvae transformed before reaching the laboratory, as often happened, the puparia would be found within the tissue envelope with their records. This system proved exceedingly convenient for collecting at random, for a small tin box and a supply of tissue paper could be carried in a pocket and thus it was possible to collect at any time. Many rare host records for certain species were obtained in this way.

HANDLING THE MATERIAL AT THE LABORATORY

Ordinarily the larvae were not yet mature when they reached the laboratory, and it was therefore necessary to allow them to continue to feed. Larvae that naturally left the wilted leaves and entered the fresh ones were easy to rear, but those that did not go to the fresh leaves were more difficult. Often the leaves would wither or decay before the larvae were full-grown.

Round tin boxes proved the most satisfactory receptacle for rearing purposes. They were fairly tight and of convenient size, and a large number could be stacked away in a comparatively small space. As a rule the leaves remained turgid in these boxes about as long as in any form of receptacle, and usually the larvae had time to attain their full growth. The boxes were kept out of doors, in a shelter and protected from the direct rays of the sun.

When the larvae transformed they were removed to small vials (preferably one-dram vials) by means of a camel's-hair brush. The vials were then closed with cork stoppers in order to prevent evaporation, and for the short period of pupation during the summer this method worked admirably. When a larva transformed within the leaf, the puparium was cut from the leaf and allowed to dry for a few hours before the cork stopper was placed in the vial. The puparia were kept in these vials until the adults emerged. The adults were kept alive for several days in order that they might attain their proper color, since teneral specimens are practically indeterminable, especially among the Agromyzidae.

MATERIAL PRESERVED FOR STUDY

A large amount of alcoholic material, consisting of eggs, larvae, and puparia, was preserved for study. Dried leaves bearing mines were also found to be valuable. Such leaves can be softened in hot water and the larval skins and mouth hooks of the miners thus obtained.

Perhaps one of the best record forms made was that used with herbarium specimens. The study lent itself most satisfactorily to this form of record. Leaves bearing mines were preserved in the same way as is used by botanists. They were mounted on white cards, with the name of the family, the genus, and the species, of both the host plant and the insect mining the leaf. A thin sheet of celluloid was placed over each of the mounts, which were then bound together in book form and presented to the Comstock Memorial Library at Cornell University as a record of the work. Most of the herbarium specimens show very clearly the arrangement of the frass within the mines, the exit holes of the larvae, and other characters of interest. These records are supplemented by photographs. The photographs have the advantage of being more durable than the herbarium records, but they are far from being as accurate and as rich in minute details.

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REVIEW OF THE MORE IMPORTANT PAPERS DEALING WITH THE DIPTEROUS LEAF-MINERS

The habits of insects attracted attention long before attempts at identification and classification were made. It is natural, therefore, to find many early references to mining insects in literature, without any designation of the species. Often the descriptions of the host plant and the habits of the larva are so vivid that one can recognize without a doubt the species which the author had in mind. This is true of the records of Swammerdam, of De Geer, and of Réaumur.

Like many other interesting phenomena of nature, the mining habit of insects was first mentioned by Swammerdam (1758). The habits of many leaf-miners are described in the work cited, and many mines are shown in drawings, but few of the miners can be singled out as dipterous. Réaumur (1737) was the first to consider the habits of the leaf-miners at any length. He distinguished three types of mines — the linear, the blotch, and the trumpet-shaped. He also mentioned three orders of insects which mine the leaves of plants: the Lepidoptera, which he called *papillons*; the Coleoptera, which he called *scarabes*; and the Diptera, which he distinguished as *mouches*. Somehow he overlooked the Hymenoptera. His observations are remarkably accurate, and, although he does not mention the species of insects, he has in most cases figured the mines and mentioned the plants on which they occur.

De Geer (1752) might also be mentioned in the same class with these earlier writers. His work resembles that of Réaumur in that it has many figures of the mines, and notes on the habits of the insects.

The work of Rennie (1846) is similar to that of the writers already named. He says of the miners:

> The process of mining between the two membranes of a leaf is carried on to more extent by minute caterpillars allied to the tent-makers . . . A few of these mining caterpillars are the progeny of small weevils (Curculionidae), some of two-winged flies (Diptera), but the greater number are produced from a genus of minute moths (Oecophora, Latr.).

No mention is made here of the hymenopterous leaf-miners. Rennie quotes from Bonnet, calling the mines "tiny miracles of nature."

The classical works of Taschenberg (1871), Kaltenbach (1872–74), Glover (1874), Camerano (1879), Brischke (1880), Karsch (1883), Girard (1885), and Leonardi (1900), should be mentioned in passing. These works were found invaluable in collecting miscellaneous records of European leaf-miners. A more recent European paper is that of Linnaniemi (1913). This is an attempt to monograph the leaf-miners as a whole, but little consideration is given to the American species. Hendel's paper (1918), while of more recent date, is of value chiefly to the systematist, although it includes many new food-plant records.

Among the earlier systematic writers whose works have been consulted constantly, are Linnaeus, Fallén, Meigen, and Fabricius. Many of the leaf-mining and other species of Diptera have been described by these writers. The work of Zetterstedt, Macquart, Robineau-Desvoidy, Schiner, Van der Wulp, Loew, and Osten Sacken, is much like that of the preceding investigators, but was done at a later date. These last-named writers have worked more or less generally on the order Diptera, and their work includes many valuable notes on the leaf-mining forms.

Among present-day workers on the Diptera are Aldrich, P. Stein, Kertesz, Melander, and Malloch. Aldrich's catalog of the North American Diptera (1905) is very valuable to every worker on this order, and especially to the worker on the habits of dipterous species. P. Stein (1898, 1906) and Malloch (1920, a and b) furnish the chief source of information on the leaf-mining Anthomyiidae. Melander (1913) and Malloch (1913, a and b), in their various papers on the Agromyzidae, contribute much information on this group of Diptera.

LEAF-MINING HABIT, AND MINES OF DIPTERA

ADAPTATIONS TO THE LEAF-MINING HABIT

The larvae of most of the leaf-mining Diptera are highly specialized, although in a few families they are more primitive. In the families in which the leaf-mining habit is well established, the larvae are specialized; while in the families in which this habit is not definitely established, they are more primitive. This would indicate that leaf-mining is a highly specialized habit.

The more primitive species are the first to be considered here. In such families as the Tipulidae, the Cecidomyiidae, and the Chironomidae, the larvae have a definite head, with mandibles, maxillae, eyes, and antennae. The body is composed of a head, a thorax, and ten abdominal segments. In their adaptation to an aquatic existence, these larvae have developed certain specialized characters such as prolegs, sucking disks, posterior breathing tubes, spines, and hairs. The larvae of the leaf-mining species of these families, however, show a much more primitive condition. They resemble the free-swimming forms in that they have a head or a " pseudo-cephalon " and mouth parts, but they differ in that they lack posterior breathing tubes, suckers, spines, and hairs. The projecting parts are reduced to a minimum. The larvae of the leaf-mining forms thus show, on the one hand, a more primitive structure, but, on the other hand, a tendency toward specialization by the reduction of protruding parts, in order to fit them to their environment.

The larvae of the specialized families of leaf-miners, as the Anthomyiidae, the Trypetidae, the Drosophilidae, and the Agromy-

zidae, show very little difference in structure from the larvae with other habits in these families. The leaf-mining larvae are all highly specialized, with no head capsule, mandibles, nor maxillae. The mouth parts are replaced by the pharyngeal skeleton. The antennae are reduced to minute, one-segmented appendages, and the eyes are absent. In certain of the leaf-mining families, the ambulatory setae are prominent structures.

ORIGIN OF THE LEAF-MINING HABIT IN DIPTERA

It is undoubtedly true that the leaf-mining habit in some of the families of Diptera originated in connection with their aquatic life. It is believed that in the beginning all insect life was terrestrial. As insects took to the water, various adjustments were made in the different families to fit them for aquatic life. Among the aquatic Diptera the commonest and most primitive forms are the free-swimming larvae, such as those of the families Dixidae and Culicidae. In tracing the development of the mining habit, therefore, these primitive forms will be considered first. They feed on any small plants which they may find in the water. The more specialized forms, such as Blepharocera, attach themselves to the surface of rocks and wait for small plants to come their way. In a third group, which includes some of the species of Cylindrotominae (the leaf-eating crane-flies), the larvae attach themselves to the plants on which they feed. Perhaps the inability of legless larvae to cling to aquatic plants has, through the process of evolution, eliminated many of these forms.

The next step is closely related to the previous one, and exists in the larva of *Cricotopus sylvestris* Fabr. (Chironomidae). The larva of this species feeds on the surface of the leaves of *Victoria regia*, forming a channel as it progresses. As already stated, these channels or galleries have been incorrectly called mines. They are the forerunners of the true mines, and one can readily see how these channels have sunk deeper and deeper into the leaf, until finally they have come to assume a position entirely within the leaf. Here may be mentioned a truly aquatic leaf-miner, *Hydrellia* n. sp. (Ephydridae), which mines in the leaves of *Potamogeton amplifolius*.

It is very easy to understand how terrestrial leaf-mining forms developed from the aquatic forms, as the plants in which they mined emerged from the water. As a matter of fact, all leaf-mining larvae live in semi-aquatic conditions in the sap that fills the mines within the leaf. It therefore makes little difference whether the leaf is in or out of the water.

The leaf-mining habit may have arisen independently in different families, from other well-established larval habits. It is shown in table 1 that the predominating habits of the other members of the families

in which the leaf-miners occur, are plant feeding and scavenging. It is possible that the scavenger habit developed before the plant-feeding habit, the larvae having first gained entrance to the plant through decayed roots or stems. Some writers would take exception to this hypoth-

TABLE 1. RELATION BETWEEN THE FAMILIES, GENERA, AND HABITS OF LEAF-MINING DIPTERA, AND THE TYPES OF MINES PRODUCED

Family	Genera	Classification as to principal habits	Type of mine
Tipulidae	Dicranomyia*	Scavengers and plant feeders	Linear (one species)
Chironomidae	Cricotopus Chironomus	Scavengers	Not true leaf mines
Cecidomyiidae	Monarthropalpus	Plant feeders and gall makers	Blotch
Trypetidae	Acidia Oxyna* Spilographa*	Plant feeders in flowers, fruits, and stems	Blotch
Agromyzidae	Agromyza Phytomyza Cerodonta Dizygomyza* Domomyza* Liriomyza* Melanagromyza* Napomyza	Plant feeders, leaf and stem miners, and gall makers	Blotch and linear
Drosophilidae	Scaptomyza	Scavengers	Blotch
Ephydridae	Hydrellia Notiphila	Scavengers	Blotch
Anthomyiidae	Chirosia* Pegomyia Hylemyia	Mostly plant feeders	Blotch
Cordyluridae	Parallelomma	Mostly scavengers	?

* Exotic.

esis, contending that insects first became established on living material, and, as the host died, became adapted to a saprophytic, or scavenger, habit. This is true of certain Sarcophagidae, which have become scavengers while most species of the family are parasites. It seems plausible, however, that in the leaf-miners the adaptation is working in the re-

verse direction, and that the scavenger habit is the more primitive. According to this hypothesis, the larvae, having first entered the plant as scavengers, became adapted to an existence within the living host and finally migrated to the stems and leaves, where they are now known as leaf-miners. It appears that during the process of adjustment the more specialized groups, such as the Anthomyiidae and the Agromyzidae, became better established as leaf-miners than the more primitive families, which seem to be in the process of adapting themselves to the mining habit. These latter families contain fewer mining species, and some species show an unsettled larval habit. For example, *Scaptomyza adusta* Loew sometimes mines and sometimes feeds as a scavenger. The species has been reared as a miner, without a doubt, from several species of Cruciferae. Sturtevant (1916), speaking of the genus Scaptomyza, says, "The larvae are not exclusively leaf miners, as I have bred *S. adusta* Lw. and *S. graminum* Fall. through several generations on tomato fruits and also on potato tubers." The species *adusta* appears to be in the process of adapting itself to the mining habit.

The foregoing discussion implies that in Diptera the leaf-mining habit has developed entirely from the scavenger habit by passing through the boring habit. There is no doubt that this is the condition in Lepidoptera, but there are indications that in some of the families of Diptera the leaf-mining habit may have developed more directly. After a species has become established on decayed leaves, it is easy to see how it could adapt itself to living leaves. Such species as *Mesogramma polita* (Syrphidae), and the leaf-feeding crane-flies (Cylindrotominae, of the family Tipulidae), represent Diptera which have become adapted to open feeding on the leaves of plants. *Mesogramma polita* is a terrestrial form, while the leaf-eating crane-flies are aquatic in their habits. In the crane-flies the specialization has been carried to such a degree that the larvae are greenish in color, to match the foliage on which they feed. From such forms as these, the mining habit may have developed directly in a manner similar to that discussed in connection with the aquatic larvae.

DEFINITION OF A MINE AS UNDERSTOOD IN THIS STUDY

Many phenomena which in the literature of the subject have been called mines are not considered to be mines in the classification used in this study. For example, the paths made by larvae through the interior of the fruits or stems of plants, and the galleries or channels eaten on the surface of the leaves of certain aquatic plants by species of Chironomidae, are sometimes called mines. These, however, are not included as mines in this study. Webster has defined a mine as "an excavation or cavity dug out," and this definition explains the term as it is used in this study. Dipterous mines here include only cavi-

ties made within the leaf and inclosed by the two epidermal layers. Unfortunately the Germans use the word "Gallerie," and in reading German articles it is sometimes difficult to determine whether the writer means a gallery or a channel in the leaf, or whether he means a mine as here defined.

TYPES OF MINES PRODUCED

The various kinds of mines produced by the Diptera can be classified under three distinct types — linear, linear-blotch, and blotch. The long, narrow, and tortuous *linear mines* are undoubtedly the primitive type, and they occur chiefly in the primitive families, as Tipulidae. Only an occasional linear mine is found in the specialized family Agromyzidae, and none are found in the Anthomyiidae. A further reason for believing that the linear mine is primitive is because all the blotch mines have their origin in a linear mine. As the larva enlarges its mine to form a blotch, the primary linear mine is obscured. This primary mine is often very short, not more than an eighth to a quarter of an inch long.

Some of the linear mines are very narrow at their beginning and gradually enlarge, somewhat resembling a serpent. Such mines are called *serpentine mines*. Other mines are intermediate between the linear and the blotch types. These are common with the Diptera, and, for want of a better name, are called *linear-blotch mines*. They start as linear mines and suddenly change to the blotch type. They differ from the trumpet mines of the Lepidoptera in that the linear part does not enlarge gradually to form a blotch, but makes an abrupt connection with the enlarged part.

The *blotch mines* are considered the most specialized of the three types, for reasons that have already been pointed out. There is little difference, however, between the blotch and the linear-blotch mine. In the former the primary linear mine becomes obscured by the blotch mine, while in the latter the original linear mine remains evident, and is usually of considerable length. The linear-blotch mines are produced by solitary miners. This perhaps explains their formation, since a single larva can mature in its mine without enlarging it sufficiently to cross the original linear tract and so obliterate it.

DISTINGUISHING CHARACTERS OF DIPTEROUS MINES

The mines produced by the Diptera resemble so closely those of other orders that it is difficult to give characters for distinguishing them. A few remarks may help in separating some of them.

The trumpet mine seems to be strictly a lepidopterous type, while the linear-blotch mine is a dipterous type. The blotch mines of the Diptera, the Lepidoptera, the Hymenoptera, and the Coleoptera, can be separated only by dissecting and examining the larvae within them.

The linear and serpentine mines occur mostly among the Lepidoptera and the Diptera. As a rule, the linear mines of the Lepidoptera are very shallow; in many instances they have been described as snail traces. Furthermore, these mines are usually characterized by a distinct central frass line, although such a line is found rarely in a dipterous linear mine. One species of Diptera, *Phytomyza obscurella* var. *nigritella* Zett., has a distinct frass line, while a few others have an indistinct line or a row of dots. The final criterion is an examination of the insect that produced the mine.

The remarkable similarity between certain lepidopterous and dipterous mines may well be mentioned here. Several species of lepidopterous miners have been reared from the poplar, and among them is one that resembles very closely a dipterous miner which the writer found on the same host. The Lepidoptera is a species of Bucculatrix, but the Diptera has never been reared nor determined. Both miners work on the under surface of the leaf. The mines of both are whitish in color, and both have a semicircular slit through which the larva escapes. The lepidopterous mine is the smaller of the two, is somewhat trumpet-shaped, and has an indistinct frass line, while the dipterous mine is linear or blotch-shaped and has the frass scattered about in small dots.

Two similar miners occur also on the violet. One is a species of Hymenoptera, and the other is a Diptera. Both produce blotch mines which are whitish in color and occur on the upper surface of the leaf. The dipterous miner is a common species, *Agromyza platyptera* var. *coronata* Loew. There are no characters by which the two mines can be separated.

CLASSIFICATION OF DIPTEROUS MINES

There are many ways in which mines can be classified. The first and most logical method would be according to types. These types have already been discussed. The mines can be further classified according to their position on the leaf, the number of larvae within a mine, the arrangement of the frass, the position of the puparium, and the exit holes made by the larvae as they escape from the leaf.

Considerable variation is shown in the position of the mine on the leaf. The larvae of most species show a preference for the upper surface, although those of a few species are found only on the lower surface. Striking examples of the latter are two species mining the leaves of poplar and willow, respectively. Neither of these dipterous miners has been identified. Some species, of which *Cerodonta femoralis* Meig., *Agromyza parvicornis* Loew, and *Agromyza laterella* Zett., are good examples, alternate between the upper and the lower surface of the leaf.

Both solitary and gregarious habits are found among the leaf-mining Diptera. In a strict sense, all leaf-miners are solitary, because they

TABLE 2. CLASSIFICATION OF THE MINES PRODUCED BY DIPTEROUS LARVAE IN THE VICINITY OF ITHACA, NEW YORK

Miners			Description of mine				
Species	Habit of larva	Position of puparium	Type	Color	Position on leaf	Arrangement of frass	Exit hole
Monarthropalpus buxi Lab.	Solitary	Within mine	Blotch	Greenish white	Chiefly on upper surface	In small spots	None
Acidia heraclei Linn.	Gregarious	Within mine	Blotch	Greenish, later brown	Visible from both sides	In small spots	None
Agromyza allecta Melander	Solitary	Outside mine	Blotch	Whitish	On upper surface	Scattered	Not definitely known
Agromyza angulata Loew	Solitary	Outside mine	Blotch	Whitish	Visible from both sides	Not definitely known	Not definitely known
Agromyza borealis Mall.	Solitary	Outside mine	Linear-blotch	Whitish to green	On upper surface	Indistinct, abbreviated line	Crescent slit on under surface
Agromyza curripalpis var. *texana* Mall.	Solitary	At end of mine on under surface	Linear	Green	On upper surface	Several masses	None
Agromyza laterella Zett.	Solitary	In a gall	Linear	White	Alternating between upper and lower surfaces	Scattered	Crescent slit on upper surface
Agromyza melampyga Loew	Solitary	Outside mine	Linear-blotch	White	On upper surface	Scattered	Crescent slit on upper surface
Agromyza parvicornis Loew	Solitary	Outside mine	Blotch or linear	Whitish to greenish	Alternating between upper and lower surfaces	Scattered	None
Agromyza platyptera var. *coronata* Loew	Solitary	Attached within mine	Blotch	Brown	On upper surface	Scattered	None
Agromyza posticata Meig.	Solitary	Outside mine	Blotch	Brown	On upper surface	Scattered	Not definitely known
Agromyza pusilla Meig.	Solitary and gregarious	Outside leaf	Linear or blotch	Whitish to greenish	On upper surface	Scattered	Crescent slit on upper surface

Agromyza reptans var. *subnigripes* Mall.	Solitary	Outside mine	Blotch	Brown	Visible from both sides	Scattered	Not definitely known
Cerodonta femoralis Meig.	Solitary	Within mine	Linear	Whitish, turning red	Alternating between upper and lower surfaces	Faint frass line	None
Phytomyza albiceps Meig.	Solitary	Outside mine	Linear	Greenish to whitish	On upper surface	Indistinct or prominent frass line	Crescent slit on upper surface
Phytomyza aquilegiae Hardy	Solitary	Outside leaf	Linear	White or pale green	On upper surface	Indistinct frass line	Crescent slit on under surface
Phytomyza chrysanthemi Kowarz	Solitary	Within mine	Linear	Whitish	On upper surface	Scattered	None
Phytomyza nitida Melander	Solitary	Within mine	Linear	Whitish	Visible from both sides	Scattered in large spots	None
Phytomyza obscurella var. *nigritella* Zett.	Solitary	At end of mine; spiracles protruding	Linear-blotch	Green	On upper surface	Spots in a distinct row	None
Scaptomyza adusta Loew	Gregarious	Within or outside mine	Blotch	Whitish to green	On upper surface	Scattered in large spots	No definite exit hole
Pegomyia calyptrata Zett.	Gregarious	Usually outside mine	Blotch	Brown	On upper surface	Scattered	No definite exit hole
Pegomyia hyoscyami Panz.	Gregarious	Usually outside mine	Blotch	Brown	On upper surface...	Scattered	No definite exit hole
Pegomyia vanduzeei Mall.	Gregarious	Usually outside mine	Blotch	Brown	On upper surface	Scattered	No definite exit hole

hatch from eggs laid singly on the surface or within the leaf, and as the larva emerges from the egg it must start its own mine. Since the eggs are often laid adjacent to one another, the mines soon coalesce, and miners with such habits have, in the broad sense, been termed *gregarious*. All true linear miners are solitary. The blotch miners have both solitary and gregarious habits.

The arrangement of the frass in certain mines is very characteristic. In the mine of *Phytomyza obscurella* var. *nigritella* Zett., on peach and on cherry, the frass is arranged in a distinct line of spots; no other dipterous or lepidopterous mine could be confused with it. The mine of another Diptera, *Phytomyza albiceps* Meig., bred from aster and goldenrod, has the frass in a prominent central line, resembling a lepidopterous mine in this respect; on other hosts, however, the mine of this species often has an indistinct frass line. In the remainder of the Diptera the frass is arranged in indistinct lines or is scattered about the mine.

The position of the puparium has been found constant for each species. Most of the larvae, on maturing, cut a slit in the side of the mine, through which they escape. In some species the puparium is formed in the ground or beneath leaves or rubbish, although in many species the larva transforms within the leaf and the puparium has a definite place in the mine. Some puparia are found loose within the mine, while others are attached to one wall by means of a pellet of frass. Some are found in side channels to the main line. These channels, which are evidently constructed for the purpose, may be found either on the same side of the leaf on which the mine occurs, or on the opposite side. Still other puparia are found with the puparial spiracles projecting through the epidermis of the leaf, and some protrude halfway from a slit made at the side of the mine. A few puparia are found attached to the exterior of the leaf, adjacent to the emergence hole. These would probably have fallen to the ground had they not been moist when they issued, which made them stick to the leaf. Such puparia are often found rigidly attached to the outer surface of the leaf.

The exit holes made by the larvae in escaping from the leaf add further characters for classifying the mines. Many of the miners, especially those of the Anthomyiidae, make no definite exit holes but break through the parchment-like surface of their mines. The usual type of hole made by the other larvae is a small semicircular slit. The position of these holes varies according to the type of mine; in the blotch mine they are made at the side, and in the linear mine usually at the end. *Agromyza pusilla* Meig., when mining on nasturtium, usually retreats about a quarter of an inch from the end of its burrow and makes a slit parallel to the sides of the mines. As far as is known, this is done by no other species.

The classification of the mines in accordance with the foregoing paragraphs, as applied to the species found in the vicinity of Ithaca, New York, is shown in table 2 (pages 16 and 17).

A KEY TO THE MORE COMMON LEAF-MINING DIPTERA, BASED ON TYPE OF MINE PRODUCED

1. Linear or serpentine mines, at least in part linear.....2
   Blotch mines, the linear part becoming obscured immediately.....17
2. True linear or serpentine mines.....3
   Linear-blotch mines.....15
3. Mines comparatively short, broad, seldom tortuous.....4
   Mines long and more or less tortuous.....10
4. Mines occurring on upper side of leaf, the larva escaping through a crescent-shaped slit.....5
   Mines on lower side of leaf, or alternating from upper to lower side.....6
5. Frass usually prominent, on Aster a prominent frass line, on *Symphoricarpos racemosus* and *Heracleum lanatum* not so prominent.....
   Phytomyza albiceps Meig.
   Frass not prominent, scattered; mine varying from linear to linear-blotch and blotch; occurring on a large number of host plants.....
   Agromyza pusilla Meig.
6. Mine on lower side of leaf, white, narrow at first, later becoming broad and almost blotch-like; frass in distinct spots; occurring on *Populus* species....
   An undescribed species
   Mine distinctly visible from both surfaces of leaf.....7
7. Mine very broad, almost a blotch.....8
   Mine narrow, thread-like.....9
8. Mine white, visible for its entire length from upper and lower side of leaf; occurring on *Smilacina racemosa*.....An undescribed species
   Mine alternating from upper to lower side of leaf, never visible from both sides at the same time.....*Agromyza parvicornis* Loew
9. Mine deep, conspicuous, later becoming red in color, alternating from upper to lower side of leaf; occurring on grasses.....*Cerodonta femoralis* Meig.
   Mine shallow, inconspicuous, white in color, alternating from upper to lower side of leaf; occurring on Iris.....*Agromyza laterella* Zett.
10. Mine with a conspicuous central dotted frass line.....
    Phytomyza obscurella var. *nigritella* Zett.
    Mine with or without a frass line, but never with a dotted frass line.....11
11. Mine on under side of leaf, white in color; puparium formed in leaf; occurring on *Lactuca scariola* var. *integrata*.....*Phytomyza lactuca* n. sp.
    Mine on upper side of leaf.....12
12. Puparium formed in mine, bulging from lower side of leaf.....
    Agromyza curvipalpis Zett.
    Larva abandoning mine to transform.....13
13. Mine white; no definite arrangement of frass, which is scattered in small spots; mine conspicuously tortuous, slightly visible from lower side of leaf; puparium usually attached to surface of leaf adjacent to exit hole.....
    Phytomyza aquilegiae Hardy
    Mine green or brown, not so tortuous as preceding; a double frass line.....14
14. Mine green, with pale white edges; occurring on *Cornus circinata*.....
    An undescribed species
    Mine brown, without pale edges; occurring on raspberry, strawberry, and blackberry.....*Agromyza fragariae* Mall.

15. Script-like tracings preceding blotch part of mine.....*Agromyza borealis* Mall.
No script-like tracings.....16
16. Mine occurring on *Ulmus americana*.....*Agromyza ulmi* n. sp.
Mine occurring on *Philadelphus grandiflorus*.....*Agromyza melampyga* Loew
17. Mine digitate; frass in spots at edge of mine.....*Scaptomyza adusta* Loew
Mine a simple blotch.....18
18. Mine large, messy, covering nearly the entire leaf.....19
Mine smaller, covering only a small part of the leaf.....21
19. Frass in small spots scattered about mine; mine occurring on parsnip and on *Cryptotaenia canadensis*.....*Acidia heraclei* Linn.
Frass soft, scattered about mine irregularly.....20
20. Mine occurring on Rumex.....*Pegomyia calyptrata* Zett., *vanduzeei* Mall., *bicolor* Wied., *winthemi* Meig.
Mine occurring on Cheñopodiaceae.....*Pegomyia hyoscyami* Panz., *Hylemyia fugax* Mall.
21. Mine very small; puparium fastened within mine by a pellet of frass; occurring on Aster and Solidago.....*Agromyza platyptera* var. *coronata* Loew
Mine larger; puparium not fastened within mine as described above.....22
22. A distinct white area around edge of mine; frass deposited in center of mine; occurring on *Thalictrum polygamum*.....*Phytomyza plumiseta* n. sp.
No white area about edge of mine.....23
23. Mine showing distinct etchings in the form of semicircular cuts made by mouth hooks of larva.....24
Mine without such etchings.....25
24. Mine occurring on *Helianthus annuus* and *Urtica gracilis*.....*Agromyza reptans* var. *subnigripes* Mall.
Mine occurring on Aster and Solidago.....*Agromyza posticata* Meig.
25. Mine on under side of leaf, occurring on Bidens, Arctium, and Eupatorium.....*Agromyza allecta* Melander
Mine on upper side of leaf, occurring on *Camptosorus rhizophyllus*.....*Agromyza felti* Mall.

HOST PLANTS OF DIPTEROUS LEAF-MINERS

For the most part, the Diptera prefer non-woody, herbaceous plants, the leaves of which are thicker and more succulent than those of woody plants. This preference may be explained in part by the structure of the larvae. While they are perhaps more specialized than those of the Lepidoptera, the Coleoptera, or the Hymenoptera, they are not so well adapted to mine in the tougher leaves of the woody plants. The mandibles of the other orders of mining insects are no doubt more efficient for mining the leaves of woody plants than are the mouth hooks of the Diptera.

The families of plants attacked by the dipterous leaf-miners are listed in table 3, together with the number of North American genera and species of larvae mining in these families. It will be noted that but two families of woody plants are included in this list, and that most of the leaf-mining species attack a comparatively small number of the host families. Among the principal host families are the Compositae, the Gramineae, the Cruciferae, the Leguminosae, and the Umbelliferae.

TABLE 3. FAMILIES OF PLANTS ATTACKED BY LEAF-MINING DIPTERA, AND NORTH AMERICAN GENERA AND SPECIES MINING IN THESE FAMILIES

Host plant			North American leaf-mining Diptera attacking plant family	
Family	Number of genera	Number of species*	Number of genera	Number of species*
Polypodiaceae	6	11	1	1
Equisetaceae	1	1	.....	.....
Najadaceae	1	1	1	1
Gramineae	30	45	3	10 (1 doubtful)
Cyperaceae	3	3	1	3
Juncaceae	1	1	.....	.....
Liliaceae	6	7	.....	.....
Iridaceae	1	5	1	1
Orchidaceae	1	1	.....	.....
Salicaceae	2	9	1	1
Betulaceae	2	5	.....	.....
Fagaceae	1	1	1	1
Urticaceae	6	8	1	3
Polygonaceae	2	11	1	5
Chenopodiaceae	4	12	3	8 (2 doubtful)
Amaranthaceae	1	1	3	3
Caryophyllaceae	8	21	.....	.....
Portulacaceae	1	1	1	1
Ranunculaceae	9	21	2	6
Magnoliaceae	1	1	1 (doubtful)	1 (doubtful)
Papaveraceae	1	4	1	1
Cruciferae	18	26	4	8 (1 doubtful)
Crassulaceae	1	2	.....	.....
Saxifragaceae	2	2	1	1
Hamamelidaceae	1	1	1	2
Rosaceae	9	18	2	2
Leguminosae	17	44	4	11
Oxalidaceae	1	1	.....	.....
Geraniaceae	1	3	3	3
Euphorbiaceae	1	3	.....	.....
Buxaceae	1	1	1	1
Aquifoliaceae	1	4	1	2
Balsaminaceae	1	4	1	1
Vitaceae	1	1	1	2
Malvaceae	4	5	1	2
Ternstroemiaceae	1	1	.....	.....
Cistaceae	1	1	.....	.....
Violaceae	2	2	1	1
Onagraceae	1	1	.....	.....
Araliaceae	1	1	.....	.....
Umbelliferae	22	32	3	5

* Including varieties.

TABLE 3 (*concluded*)

Host plant			North American leaf-mining Diptera attacking plant family	
Family	Number of genera	Number of species*	Number of genera	Number of species*
Cornaceae	1	3	.....	.....
Primulaceae	1	2	.....	.....
Oleaceae	1	1	.....	.....
Gentianaceae	1	1	.....	.....
Asclepiadaceae	1	3	1	1
Convolvulaceae	1	2	1	1
Polemoniaceae	1	2	.....	.....
Hydrophyllaceae	1	1	.....	.....
Cyrtandraceae	1	1	.....	.....
Boraginaceae	10	15	1	2
Verbenaceae	1	1	1	2
Labiatae	12	22	2	3
Solanaceae	7	10	2	3
Scrophulariaceae	5	17	.....	.....
Bignoniaceae	1	1	1	1
Myoporaceae	1	1	.....	.....
Plantaginaceae	1	4	2	6
Rubiaceae	3	3	.....	.....
Caprifoliaceae	4	19	1	3
Valerianaceae	2	2	.....	.....
Dipsacaceae	2	4	.....	.....
Cucurbitaceae	3	3	1	1
Campanulaceae	1	3	.....	.....
Lobeliaceae	1	1	1	2
Compositae	49	144	6	21
Total	287	589		

*Including varieties.

The greatest number of host plants are found within one or two families. For example, *Agromyza curvipalpis* var. *texana* Mall. mines in fifteen species of Compositae, and *Cerodonta femoralis* Meig. mines in twenty-two species of Gramineae. On the other hand, some of the species of leaf-mining Diptera are more general feeders, such as *Agromyza pusilla* Meig., which has been reported from seventeen families of plants.

RELATION BETWEEN THE LEAF-MINERS AND THE GALL-MAKERS

In a study of this sort, a question naturally arises as to why one insect forms a gall and another insect, closely related, forms a mine. This question can be answered only after a study of the habits of these

two types of insects, a consideration of the parts of the plant affected, and an understanding of the stage of development of the plant tissue at the time when it is attacked.

Gall-making is a very specialized habit among insects, and is most highly developed in the Hymenoptera. It involves many complicated processes, such as the secretion of irritating substances, the mechanical injury to the plant at the time when the egg is laid, and the irritation of the plant tissue by the jaws of the larva. The mining habit, on the other hand, is simpler, more primitive, and more easily explained. Gall-making causes an excessive growth of the plant tissue; leaf-mining produces no elevation, distortion, nor increase in size of the plant tissue. In the past, so much attention has been paid to the stimulus producing a gall that the real difference between a gall and a mine has been overlooked.

There is no doubt that the leaf-mining and the gall-making insects are closely related, and that there must be some physiological explanation for the difference in their habits. The close relationship of the two is very evident when one considers that certain genera of the Diptera, such as Agromyza and Trypeta, possess both the gall-making and the leaf-mining habit, and that different individuals of the same genus may produce both galls and mines on the same host plant. Among the Diptera are found also many interesting forms lying between these two distinct types. Frequently the stimulation produced by the insect is so slight, or is produced at such a critical time, that it is difficult to determine whether a mine or a gall has been formed. *Cecidomyia ocellaris* O. S., for example, forms on the leaf of *Acer rubrum* an elevation which is scarcely more than a mine, while *Thecodipolosis liriodendri* O. S. (Cecidomyiidae) causes on the tulip tree an injury which resembles a mine but has frequently been classified as a gall (Osten Sacken calls it a mine, while other workers refer to it as a gall). Some of the galls produced by species of Cecidomyiidae are so similar to the work of leaf-miners that specialists do not agree as to their classification. A more interesting condition is found in the larva of *Agromyza laterella* Zett., which at first mines in the outer leaves of *Iris versicolor* but later migrates to the inner developing leaves, where it sometimes produces galls.

As a general rule, the nature of the injury depends upon the condition of the plant tissue at the time when it is attacked. So far as is known, the larvae that attack the leaves while they are in the bud or before they become mature, produce galls, while those that attack the leaves after growth has ceased, form mines. The cambium of trees and roots, and the growing tips of roots, are composed of formative cells which are in the process of rapid division and growth. Such tissue is readily stimulated, by either an insect or another agency such as a fungous disease, to the production of gall. In leaves, however, the condition

is different. The undeveloped leaf, whether in the bud or immediately after the bud has burst, is composed of meristematic cells which are active and prolific. When the leaf expands and reaches its mature size, these cells become permanent and no further development takes place, except in some leaves where the cambium of the veins continues to grow It is easy to see that the stimulation of the meristematic cells would lead to the formation of a gall, while the permanent cells of the mature leaf would not be affected by this irritation. An excellent example to support this theory is found in the larva of *Agromyza laterella* Zett., to which reference has previously been made. This species produces galls only when the larvae migrate to the inner unfolding leaves where the meristematic tissue is present, while the larvae feeding on the permanent cells of the mature leaves produce mines.

It does not follow that all larvae feeding in meristematic tissue produce galls, for it is well known that certain of the Agromyza which feed in the cambium of woody trees produce mines. A few Lepidoptera also mine in the unfolding leaves of woody trees. On the other hand, the writer has not been able to find any species of insects which produce galls on the mature leaf, although such a condition might possibly exist where the cambium of the veins is attacked. Mr. Lewis Weld, of the United States National Museum, states that some of the Cynipidae apparently make galls on mature leaves. Fresh galls have been found, on perennials, on leaves formed the previous year. Whether or not these galls originated in mature tissue is questionable.

It would seem, then, as though a special stimulus or irritation is necessary for the production of galls, and that the mere presence of larvae in the meristematic tissue of plants is not sufficient to start gall formation.

The relation between leaf-miners and gall-makers in the genus Agromyza and in the family Cecidomyiidae is summarized in tables 4 and 5, respectively:

TABLE 4. RELATION BETWEEN LEAF-MINERS AND GALL-MAKERS IN THE GENUS AGROMYZA

Species	Habits	Food plants
Agromyza tiliae Couden	Gall-maker	*Citrus* sp.
Agromyza schineri Giraud	Gall-maker	*Populus* sp.
Agromyza websteri Mall.	Gall-maker	*Wisteria* sp.
Agromyza simplex Loew	Stem-miner	*Asparagus officinalis*
Agromyza aeniventris Fall.	Pith-miner	*Trifolium* sp. *Ambrosia* sp. *Helianthus* sp.
Agromyza virens Loew	Pith-miner	*Nabalus albus* *Ambrosia* sp. *Helianthus* sp.
Agromyza amelanchieris Greene	Cambium-miner	*Amelanchier canadensis*
Agromyza aceris Greene	Cambium-miner	*Acer rubrum*
Agromyza pruinosa Coq.	Cambium-miner	*Beta nigra*
Agromyza laterella Zett.	Leaf-miner and gall-maker	*Iris versicolor*, mature leaves only
Remaining known species of Agromyza	Leaf-miners	Herbaceous and woody plants

TABLE 5. RELATION BETWEEN LEAF-MINERS AND GALL-MAKERS IN THE FAMILY CECIDOMYIIDAE

Species	Effects on host
Cecidomyia sp.	(A true gall) A globose, hoary, pubescent, yellowish white gall, on Urtica, on under surface of leaf
Thecodipolosis liriodendri O. S.	(A spot gall) A purplish blister gall with a greenish areola, on Liriodendron; center slightly elevated
Asteriomyia reducta Fall.	(A blister gall) An oval blackish gall, diameter 4 mm.; on *Aster undulatus* and other plants; gall only very slightly elevated
Monarthropalpus buxi Lab.	(A leaf mine) A yellowish or brownish, blister-like, leaf mine, diameter 2 to 4 mm.; on boxwood

ABUNDANCE, DISTRIBUTION, AND HABITS OF THE LEAF-MINING DIPTERA

The species of leaf-mining Diptera are comparatively few in number. There are scarcely sixty known leaf-mining species in America, and, while the inclusion of European forms would increase the list, even with these the total of known species is small. Certain species are very prolific and abundant. Some have a large number of host plants, and can be found almost anywhere; while others are rarer, and are limited to a few hosts or even to one host. A few species are so abundant that every leaf of their host plant may become covered with mines.

Most of the species have a general distribution throughout the country, but there are some which are found only in a limited area. The species may be divided generally into eastern and western groups. One or two species have been found restricted to the northeastern part of the country, and one species occurs chiefly in the southeastern part. Certain species are further limited by the localization of the plants on which they occur. Several species seek their host plants in swampy places, and the flies are limited to these areas. Others attack aquatic plants and are therefore to be found only in aquatic situations. Even more remarkable than these are certain species which are limited to small patches of host plants. *Agromyza felti* Mall., for example, mines exclusively on *Asplenium pinnatifidum* and *Camptosorus rhizophyllus*; in this region the latter occurs only in a small patch of several square feet in the Six Mile Creek valley at Ithaca. Still other species appear to be restricted to certain patches of plants, although the same species of plants are abundant in other places in the near vicinity.

Many of the species are European forms which have been introduced into the United States and have not spread far from their point of introduction. Boston, New York, and Washington are the chief points in the East where species have been introduced, and indicate centers of infestation.

HIBERNATION, AND NUMBER OF GENERATIONS

Most of the leaf-miners apparently pass the winter as puparia. This is particularly true in the families Agromyzidae, Trypetidae, and Anthomyiidae, which include most of the leaf-mining species of Diptera. In some instances the puparia remain in the leaves or in gall-like pockets until the following spring. In other instances the larvae fall to the ground and pupate beneath leaves or other rubbish, or penetrate the ground for a short distance.

Many of the species have several generations during the summer. From three to four generations have been found in some of the Anthomyiidae. Certain Agromyzidae, on the other hand, have but a single generation.

EGG-LAYING HABITS

In the Anthomyiidae, the large and conspicuous eggs are laid on the lower side of the leaf. The ovipositor, as might be expected, is very

generalized, because there is no need for special adaptation in such a method of egg-laying. In the Trypetidae, the Agromyzidae, the Cecidomyiidae, and the Drosophilidae, the ovipositor is elongate and adapted for making holes and inserting the eggs in the leaves of the host. An unusually long ovipositor is found in a European form, *Phytomyza varipes* Meig., the ovipositor in this species being as long as the abdomen. In the Agromyzidae the ovipositor is used also in feeding. This is discussed in a later paragraph.

FEEDING HABITS

In the Trypetidae and the Anthomyiidae, the adults feed on the surface of plant leaves, sucking up sweetened liquids that have been deposited there by aphids or other insects. They also suck nectar from flowers. Some of the female Agromyzidae have a peculiar habit of making holes in the leaves with their ovipositors and then turning about and sucking the juice from the host.

EFFECT OF WORK OF LARVAE ON LEAVES OF HOST

The Anthomyiidae make large, blister-like mines, which frequently cover the entire leaf but seldom cause it to wilt. When the leaves are young and the plant is growing rapidly, the injury is entirely overcome. The Trypetidae, on the other hand, make large, messy blotch mines in the leaves, which wilt as a result of their attack.

The larvae of Agromyzidae affect the leaves in different ways. Some produce tortuous mines which at times make very beautiful scrolls on the leaves. If these larvae become abundant they may kill the plant outright, especially if the mines are deep and large. The larvae that mine the thinner leaves cause them to wilt. If the mines are shallow, the growth of the leaf may not be affected. Some larvae cause a part of the leaf to wilt while the rest remains turgid, with the result that the leaf becomes distorted. Other species attack the unfolding leaves, giving them a wrinkled or fluted appearance. Such a condition is described under *Agromyza laterella.*

FAMILIES AND GENERA OF DIPTEROUS LEAF-MINERS

The families comprising the leaf-miners of the order Diptera are relatively few in number. Only twelve of the sixty-two families listed by Williston (1908) have leaf-mining genera. These are Tipulidae, Cecidomyiidae, Trypetidae, Anthomyiidae, Agromyzidae, Drosophilidae, Ephydridae, Cordyluridae, Oscinidae, Borboridae, Mycetophilidae, and Phoridae. The last-named four families are doubtfully included because of leaf-mining species recorded in Europe and Asia. They are discussed in another paragraph in this paper. There are therefore only seven authentic leaf-mining families.

The leaf-mining genera are scarcely more numerous than the families. The following genera have been reported from different parts of the world: Dicranomyia (Hawaii), Monarthropalpus (North America and Europe), Thecodipolosis (North America). Acidia (North America and Europe), Spilographa (Europe), Oxyna (Europe), Pegomyia (North America and Europe), Hylemyia (North America and Europe), Chirosia (Europe), Agromyza (North America and Europe), Domomyza (Europe), Liriomyza (Europe), Dizygomyza (Europe), Melanagromyza (Europe), Phytomyza (North America and Europe), Phytagromyza (Europe), Ophiomyia (Europe), Napomyza (Europe), Cerodonta (North America and possibly Europe), Scaptomyza (North America and Europe), Hydrellia (North America and Europe), Notiphila (Europe), Parallelomma (Europe), Oscinis (Ceylon), Limosina (Europe), Sciara (Europe), Phora (Europe), Chlorops (Europe), Crassiseta (Europe), Anthomyza (Ceylon), Coenosia (Europe). There is some doubt as to the reliability of the last-named eight genera. The others are, without a doubt, distinct leaf-mining genera.

The leaf-mining families and genera are well represented in the North American fauna, as is shown in table 6:

TABLE 6. Families and Genera of Dipterous Leaf-Miners in North America*

Family	Genus	Number of species†
Cecidomyiidae	Monarthropalpus	1
	Thecodipolosis (doubtful).	1
Trypetidae	Acidia	1
Agromyzidae	Agromyza	28
	Cerodonta	1
	Napomyza	1
	Phytomyza	14
Drosophilidae	Scaptomyza	3
Ephydridae	Hydrellia	2
Anthomyiidae	Hylemyia	3
	Pegomyia	6
Total, 6	Total, 11	61

* There are other species, not included in this table, the leaf-mining habits of which have not been positively established.

† Including varieties.

KEY TO THE LARVAE OF THE LEAF-MINING FAMILIES OF DIPTERA

The following key separates the larvae of the leaf-mining families of Diptera:

1. Head incomplete 2
   Head complete, well chitinized; antennae usually well developed; amphipneustic or metaphipneustic; abdominal segments not subdivided by transverse constrictions; thorax often smaller but not fused; abdomen and thorax frequently with soft hairs; last segment of abdomen invariably with conspicuous tuft of hair on dorsum, near apex. (No true leaf-miners) ..... CHIRONOMIDAE (page 31)
2. A differentiation between head and thorax 3
   No differentiation between head, thorax, and abdomen; antennae and maxillary palpi reduced to a minute segment; eyes absent; mandibles, labrum, and labium absent, replaced by a pharyngeal skeleton 4
3. Head incomplete, weakly chitinized, small; eyes and mandibles absent; antennae two- to three-jointed; body with thirteen segments, exclusive of head; usually a chitinized plate on ventral surface of second thoracic segment (*Monarthropalpus*) ..... CECIDOMYIIDAE (page 30)
   Head incomplete posteriorly, heavily chitinized; antennae longer than maxillary palpi; head retractile into first segment; the six radiating protuberances characteristic of most crane-flies absent in the leaf-mining form; regularly placed bristles absent; edges of segments with ambulatory setulae (*Dicranomyia*) ..... TIPULIDAE (page 29)
4. Larger maggots (9 to 12 mm.); posterior segment often truncate, with more or less prominent tubercles; anterior spiracles fan-shaped, with numerous stigmatal openings; posterior spiracles with three radiating stigmatal openings 7
   Smaller maggots (3 to 4 mm.); posterior segment seldom truncate and seldom with tubercles; anterior spiracle fan-shaped, semicircular, or forked; posterior spiracles usually with more than three openings 5
5. Posterior segment produced into a large tubercle bearing the posterior spiracles (*Scaptomyza*) ..... DROSOPHILIDAE (page 90)
   Posterior segment not produced into a prominent tubercle 6
6. Mouth hooks usually quadrangular or triangular, with two to four teeth ..... AGROMYZIDAE (page 33)
   Mouth hooks, in leaf-mining forms, stout and curved, with only one tooth; anal prolongation of free-swimming forms absent (*Notiphila*, *Hydrellia*) ..... EPHYDRIDAE (page 93)
7. Posterior segment not tuberculate above anal area; stigmatal slits long, subparallel ..... TRYPETIDAE (page 32)
   Posterior segment tuberculate above anal area, with two or more tubercles; stigmatal slits short, arranged radiately (*Hylemyia*, *Pegomyia*) ..... ANTHOMYIIDAE (page 95)

SPECIES OF LEAF-MINING DIPTERA

FAMILY Tipulidae

Most of the larvae of the Tipulidae are scavengers, feeding on decaying vegetation, in mud containing vegetable débris, or in rotten wood. A few species are injurious to the roots of field crops, and five species

of the Cylindrotominae feed on the leaves of terrestrial or aquatic plants. Many species are aquatic or semi-aquatic, feeding on algae and on various other kinds of vegetable matter.

The occurrence of the leaf-mining habit in the family Tipulidae is unique. A single species, *Dicranomyia foliocuniculator,* was reported and described by Swezey (1913–17). He reared it from the leaves of *Cyrtandra paludosa* and other species of Cyrtandra, in the mountains at Punaluu in the Hawaiian Islands. He states that the larvae make linear mines on the leaves and form their puparia within the mine before pupating. On examination and study, other species of the genus may be found to have the same habits. This is an interesting record because it illustrates the development of the mining habit in a very primitive family.

Family **Cecidomyiidae**

The family Cecidomyiidae can hardly be called a leaf-mining family, because it contains only one well-defined leaf-mining form, *Monarthropalpus buxi* Lab. The larvae of the Cecidomyiidae feed almost entirely on vegetable matter. Some of them live in woody galls, and others in decaying fungi and in manure; while still others form channels in leaves or beneath bark. Some are parasitic among aphid colonies, and a few are inquilines in galls produced by other species. The great majority, however, are gall producers. It is interesting to find the leaf-mining habit represented by at least one distinct species in this family. It indicates, as has been pointed out before, the close relationship between the mining and the gall-making habits.

Aside from *Monarthropalpus buxi*, there are no true leaf-mining species in this family. Felt (1918) considers this species a gall form, although other workers have referred to it as a leaf-miner. A species of the genus Thecodipolosis likewise has been called a leaf-miner by some writers and a gall-maker by others. There are, on the other hand, a large number of species of Cecidomyiidae belonging to the genera Asteromyia, Cincticornia, and Lasioptera, which make blister-like or spot galls on the leaves of goldenrod and aster. These resemble true galls only slightly; the larvae produce little or no elevation of the leaf, and there is no indication of excessive growth or noticeable enlargement of the tissues. These species have been classified by some authorities as gall-makers, and by others as leaf-miners. Felt (1918: 11) uses the term *leaf galls* in a broad sense, applying it to "all deformations definitely associated with leaves." Under such a classification, forms which produce structures almost like true galls can conveniently be included among the gall-makers. In considering the leaf-miners, the writer has included only those forms that are unquestionably classified by various workers as leaf-miners.

Genus **Monarthropalpus** Rübsaamen

The genus Monarthropalpus includes a single leaf-mining species, *M. buxi* Lab., the boxwood leaf-miner. It has undoubtedly been introduced from Europe at different times. In 1915 it was reported as established on Long Island, New York. The same year it was found also in New Jersey, Massachusetts, and California. In 1921 it was reported from Newport, Rhode Island. In 1905 it was taken from imported plants received in Washington, D. C., from Holland. It has been reported from several European countries — England, France, Germany, and Holland. It was not reported from Holland, however, until 1913, which would indicate that the first introduction of the pest into this country did not come from there.

The writer has not found the species at Ithaca, New York, but the following notes, taken from other publications, will show its life history and habits. The first indication of the mine appears as a small yellowish or greenish spot on the upper surface of the leaf. Opposite this, on the under side of the leaf, can be seen an irregular blister, caused by the maggot enlarging its mine. Later the injury becomes more pronounced, and a slight elevation, with a yellowish or brownish discoloration, is seen on the upper surface of the leaf. The larvae pass the winter in these gall-like pockets, and in the spring transform to light orange-colored pupae within the leaf. An infested leaf may contain twelve or more larvae.

The European boxwood is apparently the only food plant of the species, which is found commonly in boxwoods imported from England, France, and Holland. Inspectors from Washington, D. C., and from various places in New Jersey and New York, have intercepted the miner in making examinations of imported stock.

Genus **Thecodipolosis** Keff.

The genus Thecodipolosis includes a species, *T. liriodendri* O. S., which has been called a leaf-miner by Osten Sacken but has been included by other authorities among the gall-makers. There is no doubt that the distinction here between the mining and the gall-making habit is a matter of interpretation.

FAMILY **Chironomidae**

It has already been pointed out that none of the Chironomidae are true leaf-miners. There are several species, however, which form channels in the leaves of aquatic plants, and these have frequently been referred to the leaf-miners. They are not leaf-miners in the strict sense, because they do not work between the two epidermal layers of the leaves. It is interesting to note that two of these species, *Cricotopus sylvestris* Fabr. and *Chironomus brasenae* Leathers, are the only known species

of Chironomidae which feed on living plant tissue. The others all attach themselves to the leaves by means of silk, and feed on algae and diatoms which may come their way.

Family **Mycetophilidae**

The family Mycetophilidae appears in the list of leaf-mining families through the record of an unidentified species of Sciara mining the leaves of *Cirsium arvense*, noted by Brischke (1880). The validity of the habit of this species is questionable. Since the larvae of this genus are essentially scavengers, it is very probable that they were attracted to the decaying leaves and were not truly leaf-miners.

Family **Phoridae**

The habits of the Phoridae are extremely diverse. A large number have been bred from decaying vegetables and other plant material and from fungi, while others feed on decaying caterpillars, insects, and arthropods. A number are parasitic and commensal in ants' nests, and one has been reported as parasitic on spiders' eggs. A much-doubted leaf-mining species, *Phora rufipes* Fall., has been added to the list by Brischke (1880), who reports it as mining the leaves of *Cirsium arvense*.

Family **Trypetidae**

The larvae of Trypetidae, so far as is known, feed entirely on living plant tissue. Many feed in the flesh of berries and other fruits, some form galls on various parts of the plant, and a third group consists of leaf-miners.

Genus **Acidia** Desvoidy

Williston (1908) mentions Acidia as a typical mining genus. Only one North American species, *Acidia heraclei* Linn. (*Acidia frateria* Loew), has been definitely associated with the mining habit, but many European species have been recorded as leaf-miners.

Acidia heraclei Linn.

1758 *Musca heraclei* Linn.
1781 *Musca onopordinis* Fabr.
1794 *Musca centaureae* var. *atra* Fabr.
1803 *Trupanea berberidis* Schr.
1826 *Trypeta centaureae* Fabr.
1834 *Acidia varipennis* Macq.
1862 *Acidia frateria* Loew
? *Trypeta liogaster* Thom.

The larvae of *Acidia heraclei* produce irregular blotch mines. Several larvae work within a single mine, thereby making it very large.

The epidermal layers of the leaf become distinctly separated, forming a large pocket within the leaf, which is often filled with considerable moisture and contains blackish frass scattered about in small spots. This gives the mine a very dilapidated and messy appearance. As the mine dries, it becomes brownish in color and the leaf curls as though it had been burned by spray material or by the sun. The mature larvae frequently transform within the mine, although they may escape and attach themselves to the surface of the leaf or hide away in a curled part of it.

This species has been found on the following plants: *Rumex aquaticus* (Boie, 1847); *Heracleum giganteum, Levisticum officinale, Sium latifolium* (Brischke, 1880); *Apium graveolens, Chrysanthemum* species (Curtis, 1860); *Cirsium arvense* (Edwards, 1914); *Carduus* species (Fabricius, 1781); *Angelica sylvestris, Helianthus tuberosus, Heracleum asperum, H. longifolium, Onopordum acanthium* (Feytaud, 1914); *Pastinaca sativa* (Glover, 1874); *Angelica* species, *Heracleum sphondylium, Levisticum* species (Kaltenbach, 1872–74); *Heracleum* species (Linnaeus, 1788); *Arctium* species, *Artemisia vulgaris* (Scholtz, 1849); *Rumex* species (Williston, 1908); *Cryptotaenia canadensis, Heracleum lanatum, Prenanthes canadense* (the writer).

The species is very generally distributed. In Europe it has been reported from England, France, Germany, Sweden, and Denmark. In America it has been recorded as abundant both in the East and in the West. The following unpublished locality records are added: C. W. Johnson, of the Boston Society of Natural History, has specimens from Brookline and Mount Greylock, Massachusetts, from Bennington, Vermont, from Darien, Connecticut, from Riverton, New Jersey, from Daytona, Florida, and from Montreal, Canada. The writer has collected and reared the species from parsnip, at Tarrytown, Ithaca, and Florida, New York.

Family **Agromyzidae**

Agromyzidae is a family of small or minute flies, the habits of many of which are still unknown. It includes the species grouped by Williston (1908) in the families Agromyzidae and Geomyzidae. The larvae seem to be largely plant feeders, and the majority are either leaf-miners or gall producers. Melander (1913) recognizes four subfamilies — Ochthiphilinae, Milichiinae, Agromyzinae, and Geomyzinae. A few of the Ochthiphilinae are parasitic on coccids and on aphids, and some produce galls. The genus Paramyia (Milichiinae) has been reported by Williston (1908) as a probable leaf-mining genus. The Agromyzidae contain many gall-making and many mining species. Some of the latter are cambium miners, but the greater number are leaf-miners. The leaf-mining forms occur in four North American genera (Agromyza, Phyto-

myza, Cerodonta, and Napomyza), and in six European genera (Domomyza, Dizygomyza, Liriomyza, Melanagromyza, Phytagromyza, and Ophiomyia).

The limits of the Agromyzidae, as understood by the writer, are very definite. The writer thus summarizes the characters, following Melander (1913): The auxiliary vein is more or less rudimentary, ending, together with the first longitudinal vein, distinctly before the middle of the wing; the basal cell is small, with a tendency to become incomplete, but the anal cell is almost always formed, although never produced. The frontal orbits are continuous with the facial orbits and with the genae; the orbital bristles descend to below the middle of the front; the center of the face is usually depressed below the level of the orbits, is not large nor arched, and is rarely protuberant. The arista is rarely long plumose, and is usually quite bare but ranges to long pubescent or even plumose. The posthumeral bristle is regularly absent. The legs are never greatly lengthened and are very rarely thickened; the tarsi are always slender, with the metatarsus the longest joint. The oral vibrissae may be present or absent; the wings may be pictured or not; the body may be stout or rather slender; the color may be dark or light; the proboscis may be long or short; the vestiture may consist of a dense pruinosity or the insect may be highly polished; the body may have many or few bristles or may be clothed with hairs.

The description of three new genera of Agromyzidae — Melanagromyza and Dizygomyza (Hendel, 1918), and Haplomyza (described by Hendel in 1914 [1918])— warrants some explanation here. Domomyza, Agromyza, Ophiomyza, and Melanagromyza, in which the auxiliary vein ends in vein 1, are separated from Cerodonta, Haplomyza, and Dizygomyza, in which the auxiliary vein is separated from vein 1 and terminates in the break in the costa. Melander (1913) uses this character for separating the Ochthiphilinae from the Milichiinae, the Agromyzinae, and the Geomyzinae. Hendel uses the color of the halteres for separating Domomyza and Agromyza, with pale halteres, from Ophiomyia and Melanagromyza, with black or brown halteres. Malloch (1913 b) uses this character for separating the species of Agromyza in Fallén. In Domomyza the costa extends only to the third longitudinal vein, while in Agromyza it extends to the fourth longitudinal vein.

Cerodonta is readily separated by the presence of only two scutellar bristles, and by the third antennal joint ending in a distinct point. Haplomyza is separated by Hendel from Liriomyza and Dizygomyza by the absence of the posterior cross-vein. In Dizygomyza the scutellum is black, while in Liriomyza it is entirely yellow, or at least yellow in the center.

The leaf-mining families with which the Agromyzidae are most frequently confused are the Drosophilidae and the Ephydridae. Contrasting characters which may aid in separating them are shown in table 7:

TABLE 7. COMPARISON OF THE FAMILIES MOST CLOSELY RELATED TO THE AGROMYZIDAE
(Modified from Melander, 1913)

Characters	Agromyzinae	Drosophilinae	Ephydrinae
Costa broken	Once	Twice	Twice
Auxiliary vein	Ending in vein 1	Rudimentary	Rudimentary
Anal cell	Present	Present	Absent
Basal vein of discal cell	Present	Usually absent	Absent
Cilia of calypteres	Dense	Rudimentary	Variable
Clypeus	Small	Large	Very large
Center of face	Flat	Concave	Convex
Postvertical bristles	Diverging	Converging	Converging
Oral vibrissae	Present	Present	Absent
Mesopleural bristles	Present	Absent	None to several
Arista	Closely pubescent	Plumose	Bare to plumose

Feeding habits of adults

The females of certain Agromyzidae have a peculiar way of puncturing the leaves of the host and feeding on the juices. The writer has observed this in several species of the genera Agromyza and Phytomyza. It may be that all of the Agromyzidae feed in this manner, but it has been observed in only a few species. The ovipositor is elongated and is especially adapted for inserting the eggs within the tissues of the leaf, but it serves equally well in making feeding punctures. After making a puncture in the leaf, the female turns about and sucks the juice through the hole. The feeding punctures are usually large and very conspicuous. Some species, however, make very small punctures which resemble the feeding punctures of mites or thrips.

Activities of adults

Some species of Agromyzidae issue from their winter quarters in spring, as early as April or by the first of May. Others do not appear until June or July. Several species have but one generation a year, and this appears in the spring. It is impossible to obtain either larvae or adults of these species toward the middle of summer. Other species have several generations, and are active throughout the entire summer. These keep the leaves continually covered with fresh mines.

It has often been noticed that some dipterous larvae start mines on certain plants but never complete their development. The reason for this has never been fully determined. One condition which prevents some larvae from maturing is their being subject to attack, in their mines, by certain predacious insects. The writer has found nymphs of *Nabis ferus* L. attacking the larvae of *Pegomyia calyptrata*. Tower (1915) describes a larva of Chrysopa which, he states, attacks *Agromyza platyptera* var. *jucunda* in the leaves. These predacious forms, as well as many parasitic Hymenoptera, no doubt account for many of the leaf-miners which never mature. Aside from this condition, however, it still seems impossible to rear larvae from certain plants. All attempts to rear a dipterous larva which makes a linear mine on *Arctium lappa*, have failed. It appears that the larvae are not able to mature on this plant. The same is true of many larvae collected on various plants, and it thus seems that some Diptera are more particular in their selection of food plants than has generally been believed.

Reference has already been made to the wide range of food plants of certain species of dipterous leaf-miners. This might lead to the erroneous belief that all dipterous miners are general feeders. As a rule they are more general in their feeding habits than are the Lepidoptera, but certain species are restricted to a single host family, to a single genus, or even to a single host plant. *Agromyza borealis*, for example, mines only on *Impatiens biflora* and *I. pallida*.

Structure of the larvae

The writer has made a detailed study of the larvae of Agromyzidae in order to determine characters for separating the two leaf-mining genera Agromyza and Phytomyza. The larvae of twelve species of Agromyza and five species of Phytomyza were available for this study. Clear-cut characters were found for separating most of the species, but it was difficult to find good characters for separating the two genera. The characters found are summarized in table 8:

TABLE 8. Characters for Separating the Genera Agromyza and Phytomyza

Characters	Agromyza	Phytomyza
Anterior spiracles	From 3 to 6 stigmatal openings	From 5 to 26 stigmatal openings
Posterior spiracles	From 3 to 16 stigmatal openings	From 7 to 22 stigmatal openings
Mandibular sclerites	From 2 to 4 teeth	From 2 to 4 teeth
Ambulatory setulae	Prominent	Inconspicuous or missing
Tubercles	Sometimes present	Never present

Anterior spiracles.— The larvae of Agromyzidae have three types of anterior spiracles — fan-shaped, semicircular, and forked. The first two types are the commonest. In Phytomyza the anterior spiracles tend to be approximated at the base, and project rather prominently. With respect to shape and number of stigmatal openings, the spiracles of the two genera grade into each other so that it is practically impossible to separate the genera on these characters. Certain of the species, however, have very characteristic spiracles. In *Phytomyza obscurella* var. *nigritella*, for example, the anterior spiracle is forked and has about twenty-six stigmatal openings.

Posterior spiracles.— The posterior spiracles in this family are even more varied in form than the anterior spiracles. The number of stigmatal openings varies from three to twenty-two. Larvae with three stigmatal openings resemble those of Pegomyia. The stigmatal openings, where few in number, are arranged either subparallel or radiating from a central point. The spiracles with a larger number of stigmatal openings have various forms, which are usually very characteristic of the species in which they are found.

Mandibular sclerites (mouth hooks).— It is not always easy to distinguish between the mouth hooks of different species. The number of teeth varies from two to four. In most species these sclerites are quadrangular in shape. Often they are unequal in size, the left one being the smaller. In one species, *Agromyza laterella,* they are triangular and have sharp teeth, somewhat resembling those in Pegomyia.

Ambulatory setulae.— The ambulatory setulae are minute chitinized hooks which encircle the edges of the segments in transverse bands. They serve as a means of distinguishing Agromyza from Phytomyza. In Agromyza they are almost always prominent, while in Phytomyza they are either absent or exceedingly minute.

Tubercles.— None of the Agromyzidae have prominent tubercles such as are found in Hylemyia and in Pegomyia. Some species of Agromyza have small tubercles on the lateral aspect of the last segment. There are two lateral tubercles in *A. parvicornis*, and one in *A. melampyga.* No tubercles have been found in Phytomyza.

Key to leaf-mining larvae of Agromyzidae

1. Edge of body segments with conspicuous transverse rows of ambulatory setulae (*Agromyza*).....2
   Edge of body segments without such setulae (*Phytomyza*).....12
2. Last abdominal segment with two fleshy lobes projecting from ventral posterior angle, resembling prolegs.....*Agromyza allecta* Melander
   Last abdominal segment without fleshy lobes.....3
3. Posterior stigmatal slits on curved horny projections at posterior end of body..4
   Posterior stigmatal slits at ends of short or long peduncles.....5
4. Ventral edge of second segment produced into two fleshy lobes.....*Agromyza angulata* Loew
   Ventral edge of second segment not produced.....*Agromyza borealis* Mall.

5. Posterior spiracles with three stigmatal slits.....6
Posterior spiracles with more than three stigmatal slits.....10
6. Posterior spiracles fan-shaped, with stigmatal slits at end of separate lobes; mouth hooks triangular, with 4 teeth.....*Agromyza laterella* Zett.
Posterior spiracles with slits on stigmatal plates.....7
7. Posterior spiracles with stigmatal slits subparallel.....
Agromyza reptans var. *subnigripes* Mall.
Posterior spiracles with stigmatal slits arranged radiately.....8
8. Teeth of mouth hooks exceptionally long.....*Agromyza fragariae* Mall.
Teeth of mouth hooks normal.....9
9. Peduncle of posterior spiracle long.....*Agromyza posticata* Meig.
Peduncle of posterior spiracle short...*Agromyza platyptera* var. *coronata* Loew
10. Mouth hooks with 4 teeth.....*Agromyza melampyga* Loew
Mouth hooks with 2 teeth.....11
11. Posterior segment with 2 lateral tubercles.....*Agromyza pusilla* Meig.
and *Agromyza parvicornis* Loew
Posterior segment without tubercles.....*Agromyza maura* var. *simplex* Loew
12. Anterior spiracles distinctly biforked..*Phytomyza obscurella* var. *nigritella* Zett.
Anterior spiracles fan-shaped or semicircular, but not biforked.....13
13. Mouth hooks with 2 or 3 teeth.....14
Mouth hooks with 4 teeth.....18
14. Mouth hooks with 2 teeth.....15
Mouth hooks with 3 teeth.....17
15. A tentacle on dorsum of first segment.....*Phytomyza aquifolii* R-D.
No tentacle on first segment.....16
16. Posterior spiracles semicircular, with 22 stigmatal slits.....
Phytomyza plumiseta n. sp.
Posterior spiracles semicircular, with 8 or 9 stigmatal slits.....
Phytomyza plantaginis R-D.
17. Posterior spiracles with 9 stigmatal slits, peduncle of medium length.....
Phytomyza chrysanthemi Kowarz
Posterior spiracle with 15 to 18 stigmatal slits.....*Phytomyza albiceps* Meig.
18. Anterior spiracles with 9 stigmatal slits.....*Phytomyza ilicis* Curt.
Anterior spiracles with 26 stigmatal slits.....*Phytomyza nigritella* Zett.

Descriptions of species of Agromyzidae

Genus **Agromyza** Fallén

The members of the genus Agromyza are all plant-feeders; most of them are leaf-miners, but some mine beneath the bark, and a few produce galls. *Agromyza pruinosa* Coq., *A. aceris* Greene, and *A. amelanchieris* Greene, are cambium miners; *A. tiliae* Couden, *A. schineri* Giraud, and *A. websteri* Mall., are gall-producing forms; *A. aeniventris* Fall., *A. simplex* Loew, and *A. virens* Loew, are stem-mining forms; the remaining species of this genus, as far as their habits are known, are leaf-miners.

Agromyza allecta Melander

1896 *Agromyza lateralis* Williston
1913 *Agromyza platyptera* var. *allecta* Melander

The species *Agromyza allecta* is not well known. Melander (1913) proposed for it a new name, *allecta*, since *lateralis* was preoccupied. He

considered it a variety of *A. platyptera* Thom. The writer has found structural characters in both the larva and the puparium which warrant placing it as a separate species. It differs from *coronata* Loew and from *jucunda* V. d. W., which are no doubt varieties of *platyptera* Thom. The larva of *allecta* has two prominent, fleshy prolongations at the posterior ventral angle of the last segment.

The larvae of this species make large, whitish mines on the leaves of *Arctium lappa, Bidens frondosa,* and *Eupatorium purpureum.* They are voracious feeders, and eat away the greater part of the leaf attacked. Their mines sometimes cover an entire leaf. This is a rather exceptional condition among the Agromyzidae. On *Arctium lappa* the mines are always made on the lower surface of the leaf, while on the other two hosts they are made on the upper surface. It is curious that mines have been found on *Arctium lappa* only in the vicinity of Ithaca, New York; on the other food plants they have been found very commonly in Pennsylvania, in New Jersey, and in various parts of New York.

The larvae are gregarious in habit, a number of them feeding within the same leaf. When the eggs hatch, several separate mines are formed, but these soon fuse into one. The mature larvae abandon the leaves to transform.

No food plants have heretofore been recorded for this species. The writer has reared larvae from *Arctium lappa, Bidens frondosa,* and *Eupatorium purpureum.*

The species has not heretofore been recorded from the United States. It was taken by Williston at St. Vincent, West Indies. No doubt some of the records made in the literature under *Agromyza platyptera* var. *coronata* Loew and *Agromyza platyptera* var. *jucunda* V. d. W. refer to this species. The writer has collected it at Sheldrake, Trumansburg, and Tarrytown, New York, at Arendtsville, Pennsylvania, and at Orange, New Jersey.

Larva.— Length 4.5 to 5 mm. Body dirty white, subcylindrical, distinctly tapering toward anterior end, widest at posterior end. Several rows of prominent ambulatory setulae, the edges of the last two segments especially heavily armed. Anterior spiracles semicircular, with about eleven stigmatal slits. Mouth hooks quadrangular. Dorsal angles of last segment produced into prominent tubercles bearing spiracles; posterior spiracles with three stigmatal slits. Ventral angles of last segment produced into proleg-like appendages, which are chitinized on inner margins.

Agromyza angulata Loew

1864 *Agromyza angulata* Loew

The species *Agromyza angulata* is common and is widely distributed, but its habits are not very well known. The writer has reared it as a leaf-miner from *Cyperus acuminatus.* Malloch (1913 a) records it from *Phleum pratense,* but does not mention its habits. Pergande reared it from the leaves of the same plant and also from *Setaria glauca.* The

mines are usually formed toward the tip of the blade of grass. The larvae are solitary, but several may work in a single leaf blade and the mines often fuse with one another, producing a common blotch. The mines vary in color from greenish to whitish, and are visible from both sides of the leaf.

Another species, *A. parvicornis* Loew, is commoner on the leaves of the Gramineae. The mine of this species can be readily distinguished by its more linear form, and by the fact that the larva mines alternately on the upper and the lower surface of the leaf.

This species has a wide distribution, ranging from Massachusetts south to Louisiana, and west to Wisconsin and to Washington.

Agromyza borealis Mall.

1913 *Agromyza borealis* Mall.

Agromyza borealis was described by Malloch (1913 a) from a single specimen. The writer has reared the larvae from *Impatiens biflora* and *I. pallida*. Contrary to the opinion of Malloch, this species has been found to be common and has frequently been reared and collected throughout New York and in parts of Pennsylvania.

Adults of *A. borealis* have been collected only in the vicinity of marshy or woody places. During the early part of July they become abundant in the woods. They rest on the upper side of the leaves, and their yellow bodies shine like gold in the sunlight. Before alighting on the foliage, they hover about the leaves like syrphid flies. The females puncture the host plants with their ovipositors and suck the plant juices. It is not an uncommon sight to see leaves covered with these small feeding punctures.

The mines do not become evident until about the middle of June. In 1916 they were first noticed on June 12. They were not abundant at that time, but as the summer advanced they became more abundant and very conspicuous. Toward the end of August it was impossible to find the larvae within the leaves. It appears that there is but one generation a year, and this occurs in early summer.

The mines are whitish in color, and vary from the linear to the irregular blotch type. Often the beginning of the mine is delicate and thread-like. The frass is arranged in delicate scroll-like lines, or is scattered in masses within the mine. While the mines occur only on the upper surface of the leaf, the thinness of the leaf allows them to be seen from the under side. Although the leaves of Impatiens are very thin and delicate, and wilt readily when plucked or when exposed to the sun, the work of leaf-miners does not seem to affect them. They remain turgid in spite of the extensive mining of the larvae.

The present distribution of the species is limited. The writer has reared and collected it at Ithaca and Florida, New York, and at Flora

Dale, Pennsylvania. Malloch (1913 a) mentions no locality for the specimen from which the species was described, but he later (1918) gives British Columbia as a locality.

Larva.—Length 5 mm. Body greenish white, subcylindrical. Ambulatory setulae prominent, consisting of a single row of strong setulae with two or three rows of smaller ones on each side. Anterior spiracles semicircular, with sixteen stigmatal slits. Antennae considerably separated at base. Posterior spiracles protruding from last segment as prominent, horny, curved processes bearing three stigmatal slits.

Agromyza clara Melander

1913 *Agromyza clara* Melander

The habits of *Agromyza clara* have not heretofore been published. Aldrich identified specimens found mining the leaves of *Catalpa bungei*, which were reared by J. S. Houser. The writer has seen specimens, but he has never reared nor collected the species from the East. *Agromyza citreifrons* Mall. is evidently a synonym.

The species has been collected in Washington, California, Maine, Pennsylvania, and Ohio.

Agromyza coniceps Mall.

1915 *Agromyza coniceps* Mall.

Malloch (1915 b) states that the species *Agromyza coniceps* was reared from the leaves of *Sonchus asper* from Salt Lake, Utah. It is evidently a western form and should be added to the list of North American leaf-miners.

Agromyza coquilletti Mall.

1913 *Agromyza coquilletti* Mall.

Malloch (1913 a) described the species *Agromyza coquilletti* from material bred from oats. Webster and Parks (1913) mention it in connection with its close relationship with *A. pusilla* Meig. Although the species has been recorded repeatedly from the northeastern part of the United States, the writer has never reared nor collected it in the vicinity of Ithaca, New York.

Malloch (1913 a) records the species as a miner in the leaves of *Avena sativa, Hordeum jubatum,* and *Triticum sativum.* Dr. J. M. Aldrich has specimens reared by C. N. Ainslie from the leaves of *Elymus canadensis, Triticum vulgare,* and *Zea mays.*

The species occurs from Massachusetts west to Nebraska and the Dakotas.

Agromyza curvipalpis Zett.

1846 *Agromyza curvipalpis* Zett.
1873 *Agromyza bicornis* Kaltb.

The species *Agromyza curvipalpis* has been several times recorded as a leaf-miner in Europe. Karsch (1883) records it, under the name

bicornis Kaltb., as a miner on *Solidago virgaurea* Linnaniemi (1913) records it from Denmark on the same plant. A variety of this species, *texana* Mall., has been repeatedly reared as a leaf-miner in New York. This form is discussed below.

Melander (1913) records the species from Europe, and in the United States from Massachusetts, Illinois, Louisiana, Idaho, and Washington. He has specimens from all these localities.

Agromyza curvipalpis var. *texana* Mall.

1913 *Agromyza curvipalpis* var. *texana* Mall.

Malloch's *Agromyza texana* is very close to *A. curvipalpis* Zett., and the writer has followed Melander, who in manuscript notes places it as a variety of *curvipalpis*. The three new species described by Malloch (1913 a)— *vibrissata, affinis,* and *insularis* — also are close to *texana,* and may be synonyms.

This variety has been found very commonly about Ithaca, New York, mining the leaves of several species of Solidago and Aster. It is an interesting variety because the mines produced on the two genera of plants would scarcely be recognized as having been made by the same species of insect. In both Solidago and Aster the mines occur on the upper side of the leaves, and are scarcely or not at all visible from the lower side. On the various species of Solidago from which the larva has been bred, the mine is long, serpentine, and whitish in color, with little or no visible frass. The mine on the leaves of Aster is serpentine, greenish in color, and more tortuous than the mine on Solidago, and the frass is arranged in three or four conspicuous spots. The full-grown larva transforms at the end of the mine, or sometimes in a short side channel to the principal mine. The puparium bulges from the lower side of the leaf and is not visible from the upper side.

Aldrich has in his collection specimens of this variety reared by Satteswait from the leaves of *Nepeta cataria.* Malloch (1913 a) records the variety from *Roripa* species. The author has reared it from *Aster arvensis, A. divaricatus, A. novae-angliae, A. paniculatus, A. undulatus, Eupatorium urticaefolium, Solidago caesia, S. canadensis, S. juncea, S. latifolia, and S. serotina.*

The distribution of this variety is not well known. It has been recorded from Cabin John Bridge, Maryland, from Veitch, Virginia, and from Brownsville and Kerville, Texas, by Malloch (1913 a); and from Ithaca, Trumansburg, and Florida, New York, by the writer.

Agromyza eupatoriae Mall.

1915 *Agromyza eupatoriae* Mall.

Little is known concerning the species *Agromyza eupatoriae.* It was reared by Jones (1915) from *Eupatorium odoratum* at Rio Piedras,

Porto Rico, and Malloch (1915 b) has described it. It has been collected at Ithaca, New York, but the writer has never reared it and is unfamiliar with the type of mine that it produces.

Agromyza felti Mall.

1915 *Agromyza felti* Mall.

Agromyza felti was first recorded by Felt (1911), under the name *melampyga* Loew, from the walking fern, *Camptosorus rhizophyllus*. Malloch (1915 a) described it as a new species. It runs close to *melampyga* Loew, but because of its distinct host plant and its different type of mine it may well be considered a separate species. It can be distinguished from *melampyga* Loew by the lack of posterior setulae on the mid tibiae.

The leaf of *Camptosorus rhizophyllus* is small, and the mine of *Agromyza felti* is comparatively large, with the result that the greater part of the parenchyma of the leaf is removed. The mine is whitish in color, and occurs on the upper surface of the leaf. The larvae form their puparia within the mine, and several puparia may be found within a single leaf.

Only two food plants are known for this species, *Asplenium pinnatifidum* and *Camptosorus rhizophyllus*.

The species has been recorded from Illinois and from New York. Aldrich has in his collection specimens from Mount Constitution, Washington.

Agromyza flavonigra Coq.

1902 *Agromyza flavonigra* Coq.

The habits of *Agromyza flavonigra* are not known, but in all probability the species is a leaf-miner. Melander (1913) has considered it a variety of *melampyga* Loew. Specimens have been taken by Cockerell at Beulah, New Mexico, and Melander records the species from New York.

Agromyza fragariae Mall.

1913 *Agromyza fragariae* Mall.

Coquillett (1898) mentioned a species, *Agromyza setosa* L., as mining the leaves of Chrysanthemum, Zizania, and strawberry. Malloch (1913 a), in working over the same material in the collection of the National museum, distinguished a new species from the leaves of the strawberry, which he named, from its host, *Agromyza fragariae*.

The species is common about Ithaca, New York. The adults do not become active until the latter part of June or the first of July, and the mines cannot be found until the middle of June. Mines containing larvae are abundant from that time until the end of October.

The mine is linear, and always occurs on the upper side of the leaf. It is comparatively broad, and is not tortuous like many of the linear mines. The eggs are most frequently laid near the edge of the leaf where the mine starts, and the larvae work toward the center of the leaf. The frass is sparse and is arranged in two more or less distinct rows, one along each side of the mine. The fresh mine is greenish in color, but on drying it becomes brownish. When mature, the larva escapes through a semicircular slit in the upper surface of the leaf.

Malloch (1913 a) records the species from the leaves of the strawberry (*Fragaria virginiana*). The writer has reared it from *Rubus idaeus*, the blackberry and the blackcap raspberry (*Rubus* species), and the purple-flowering raspberry (*Rubus odoratus*).

Malloch (1913 a) records the species from Placer County, California. The writer has reared it from leaves gathered at Ithaca, Tarrytown, and Florida, New York, at Orange, New Jersey, and at Arendtsville, Pennsylvania.

Larva.— Length 4.5 to 5 mm. Body distinctly thickened at anterior end, tapering suddenly toward that end and gradually toward posterior end. Anterior spiracles fan-shaped, with eight stigmatal slits. Mouth hooks quadrangular, with two teeth; these teeth remarkably long, as long as or longer than length of mandibular sclerite. Posterior spiracles projecting conspicuously from dorsal aspect of last segment, each with three radiating stigmatal slits.

Agromyza inaequalis Mall.

1913 *Agromyza inaequalis* Mall.

Malloch (1913 a) reported *Agromyza inaequalis* as a blotch-miner on lima beans collected on St. Vincent, in the West Indies, and at Rio Piedras, Porto Rico. It has been reared also from *Vigna repens*. The habits of this species are not well known.

Agromyza inconspicua Mall.

1913 *Agromyza inconspicua* Mall.

Agromyza inconspicua was described by Malloch (1913 a) from an adult bred from mines found on Agropyron collected by C. N. Ainslie, of Fort Collins, Colorado, in 1910. Aside from Malloch's description and notes, nothing is known concerning the species.

Agromyza laterella Zett.

1838 *Agromyza laterella* Zett.
1860 *Agromyza grossicornis* Zett.
1864 *Agromyza magnicornis* Loew
1880 *Agromyza faciata* Strobl
1880 *Agromyza flavocincta* Strobl
1898 *Agromyza flaviventris* Strobl

The species *Agromyza laterella* has not attracted much attention, although it is very common and widely distributed. Thompson (1907)

and Claassen (1918) have referred to its habits as a miner. This is one of the most interesting species that have been studied, because of its complex life history and the many ways in which the larvae affect the growth of the host plant, *Iris versicolor*.

The eggs are apparently laid on the inner leaves, since the first indication of the mines are seen there. The mines are at first very indistinct and are visible only with a lens. The larva works down the leaf, making a silvery white linear mine which is very shallow and resembles the snail-trace mines produced by the Phyllocnistis leaf-miners (Lepidoptera). Later the mine broadens slightly and becomes somewhat tortuous. The larva migrates from the upper to the lower side of the leaf, producing an interrupted mine on one surface. It works downward and inward, readily moving from one leaf to an adjacent leaf. Toward pupation time the larva has reached the interior of the plant, where transformation takes place. A gall-like cell is often formed, in which the puparium rests until the following spring. Claassen (1918), who has worked out the life history more in detail, says that only those larvae which had developed slowly and had entered the innermost leaves late in the fall, at the time when plant growth had ceased, were instrumental in bringing about the formation of galls.

In addition to the formation of galls, the larvae also bring about a peculiar crinkling of the leaves. The formation of galls often affects the newer leaves so that they do not grow naturally, but become distorted, slightly thickened, and wrinkled.

The species ranges from Canada south to Massachusetts and Pennsylvania, and west to Idaho and Washington.

Larva.—Length 5 mm. Body dirty white, subcylindrical, slightly thickened at anterior end, tapering toward both ends. Ventral edges of second and third segments produced, with transverse ambulatory ridges. Posterior spiracles simple, consisting of a short tubercle bearing three stigmatal slits. Anterior spiracles weakly chitinized, consisting of two unequal branches with seventeen or eighteen stigmatal slits.

Agromyza maculosa Mall.

1913 *Agromyza maculosa* Mall.

Agromyza maculosa resembles *A. angulata*, but is conspicuous and easily separated because of the black spot on the outside of the knob of the halteres. It is one of the larger species of Agromyzidae.

Coquillett (1898) referred to the species under the name *setosa* Loew. Malloch (1913 a), in looking over Coquillett's specimens, recognized and described it as a new species, *maculosa*. Melander's record (1913) for *A. setosa* Loew from New York State was probably taken from Coquillett (1898), and should, no doubt, relate to *maculosa* Mall. The species is well defined and abundant in parts of the country.

The writer has never reared this species, but Aldrich has a long series of specimens reared from *Arctium lappa.* Others of its food plants are *Bidens leucantha, Chrysanthemum indicum, and Helianthus annuus.* The species occurs in the eastern and southern parts of the United States, ranging from New Jersey south to Georgia and west to Indiana. It occurs also in the West Indies and in New Mexico.

Agromyza marginalis Mall.

1913 *Agromyza melampyga* var. *marginalis* Mall.
1918 *Agromyza marginalis* Mall.

The species *Agromyza marginalis* was originally described by Malloch (1913 a) as a variety of *melampyga* Loew. In 1918 he separated it as a distinct species. The present knowledge of the species is limited. Malloch described it from three specimens reared from *Paspalum dilatatum* by Luginbill, and records it from Columbia, South Carolina, and from Illinois. Aldrich has collected it at Dallas, Texas.

Agromyza maura var. *nasuta* Melander

1913 *Agromyza maura* var. *nasuta* Melander

Agromyza maura Meig. is a common European species, and has been reared from several food plants. The writer has reared Melander's variety *nasuta* from *Taraxacum officinale.* It is strange that, while many miners have been reared from this plant in Europe, very few records are found in American literature.

The larvae of *nasuta* mine on the stalks and the petioles of leaves, sometimes working their way to the leaves themselves. The variety is an interesting one because it lies between the leaf-miners and the stem-borers. It can scarcely be considered a stem-borer, for it does not bore into the center of the stem but mines just beneath the epidermis. It differs from the miners previously discussed, in that it mines under conditions which might seem unfavorable because of the abundant milky fluid of the host plant. Aldrich (1918 b) investigated this point in connection with the larvae of *A. pusilla,* which mine the leaves of *Asclepias syriaca,* and he found that these miners feed in the palisade cells and do not touch the lactiferous system. The larvae of *Agromyza maura* var. *nasuta* work in very much the same way. Instead of mining in the parenchyma, they mine immediately beneath the epidermis and feed on the parenchyma. Their mines are so shallow and so close to the epidermis that there is scarcely any evidence of them after the larvae have finished feeding. The positions of several larvae on different petioles were recorded by means of a short mark at each end of the larvae. At the end of a few days these larvae had moved along the petiole and had left no indication of their mines.

Melander (1913) records the species from Idaho and Washington, indicating a western distribution. The writer has collected it at Ithaca, Slaterville, and McLean, New York. Aldrich has specimens from St. Joseph, Illinois, and Winn reports the species from Aweme, Manitoba.

Agromyza maura var. *simplex* Loew

1864 *Agromyza maura* var. *simplex* Loew

Agromyza maura var. *simplex* is similar to the variety just described, *nasuta*, in that it mines the stems of plants rather than the leaves. It has been reared from asparagus, and a full account is given by Fink (1913) under the species name *Agromyza simplex* Loew.

Agromyza melampyga Loew

1864 *Agromyza melampyga* Loew
1896 *Agromyza sorosis* Williston
1902 *Agromyza flaviventris* Johnson
1913 *Agromyza melampyga* var. *flaviventris* Melander
1913 *Agromyza melampyga* var. *sorosis* Melander

Coquillett (1898) and Malloch (1913 a) record *Agromyza melampyga* from *Plantago* species. The writer has not found the species on this host, although he has reared several other species from it. *A. melampyga* is abundant about Ithaca on *Philadelphus grandiflorus*, and the writer doubts the correctness of the rearing records from *Plantago* species.

The mines produced by this species are very characteristic and are not easily confused with those of other leaf-mining Diptera. The author has reared the species from *Philadelphus grandiflorus*. On this plant the mines always occur on the upper surface of the leaves. They are whitish in color, and are partly linear and partly blotch in form. The linear part of the mine is streaked with narrow lines of frass; the blotch part is spotted in the center with irregular particles of frass. As a rule, only one or two mines are found on a single leaf, although occasionally more are found. The full-grown larva abandons the leaf to transform.

The food plants of this species are: *Plantago* species (Aldrich); *Philadelphus* species, *Plantago major* (Coquillett, 1898); *Plantago major* (Malloch, 1913 a); *Philadelphus grandiflorus* (the writer). It is interesting to note that Malloch found the species feeding on the roots of *Plantago media*.

The species ranges from Massachusetts south to Florida and west to Colorado. It has been taken also on the islands of St. Vincent and Jamaica, in the West Indies.

Larva.— Length 4 mm. Body pale yellow, subcylindrical, widest near middle, tapering gradually toward posterior end and more abruptly toward anterior end. Anterior spiracles fan-shaped, with seven or eight stigmatal slits. Mouth hooks quadrangular, with four blunt teeth. Posterior segment with a single lateral tubercle on each side. Posterior spiracles on short stalks, with nine stigmatal slits.

Agromyza parvicornis Loew

1864 *Agromyza parvicornis* Loew

Agromyza parvicornis is one of the commonest and best-known of the leaf-miners among the *Agromyzidae*. Evidently *A. dubitata* Mall. is a synonym. The abundance of this species and the seriousness of its attacks, especially on young corn, has placed it among the injurious insects. It has been given the common names *corn blotch leaf-miner* and *wheat-miner*.

The miners of this species confine themselves to a few species of Gramineae, and corn seems to be their preferred plant. They work as solitary miners, and, when not interfered with by other larvae, produce a linear mine, which becomes broader at the extremity. They alternate between the upper and the lower side of the leaf. Several larvae are commonly found working side by side. They hatch from eggs laid close together on the tip of the leaf, and mine toward the base. Adjacent mines soon coalesce and several larvae thus find themselves in a common mine.

The larvae have been found most abundant and active from the middle to the end of summer. On August 17, 1920, at Arendtsville, Pennsylvania, the writer found mines and larvae abundant, and observed adults feeding on the foliage. The females injure the foliage considerably by puncturing the leaves with their ovipositors and then turning about and sucking the juices with their proboscides. These feeding punctures, on drying, become whitish in color and very conspicuous. The feeding is usually done from the under side of the leaf.

Comstock (1881) records the species from *Zea mays;* Houser (1912) records it from *Triticum sativum*; Phillips (1914) records it from *Echinochloa crusgalli, Panicum miliaceum*, and *P. sanguinale*; and the writer has reared it from *Phleum pratense*.

The species has an exceedingly wide distribution in the United States, and has been recorded from New Hampshire to Florida, and west to South Dakota and Texas. It has been taken also in Canada (Quebec, Ontario, and Nova Scotia).

Larva.— Length 3 to 4 mm. Body greenish white, segmentation not distinct, anterior end inclined to be slightly thicker than posterior end. Anterior spiracles weakly chitinized, fan-shaped, with about eight stigmatal slits. Mouth hooks quadrangular, with two teeth. Posterior segment with two lateral tubercles on each side. Posterior spiracles not protruding prominently. Stigmatal plate with three radiating slits.

Agromyza platyptera Thom.

? *Agromyza platyptera* Thom.

There is considerable variation within the species *Agromyza platyptera*, so much that Melander (1913) has subdivided it into the

following varieties: *coronata* Loew, *jucunda* V. d. W. (*Oscinis malvae* Burgess), *allecta* Melander (*lateralis* Will.). These varieties are based, for the most part, on color characters. The variety *coronata*, with its blackish orbits and subantennal grooves, is distinguished from *jucunda*, in which the front and the face are entirely yellow. Malloch (1913 a) has thrown all three varieties in synonymy. After studying and rearing the larvae of these varieties, the writer has come to the conclusion that the variety *allecta* Melander is a distinct species, and that *jucunda* V. d. W. and *coronata* Loew are probably good varieties. *A. allecta* has already been discussed.

Agromyza platyptera var. *coronata* Loew

1869 *Agromyza coronata* Loew
1913 *Agromyza platyptera* var. *coronata* (Loew) Melander

The writer has reared the variety *coronata* repeatedly from certain food plants, chiefly the goldenrods, and because of its habits and its peculiar mine he is inclined to consider it a distinct variety. There are, however, no well-defined characters in the adults by which to separate this variety from *jucunda* V. d. W. At present it is thought wise to keep the host plants of the two varieties separate.

The larvae produce small blotch mines on the leaves of several plants, chiefly in the genus Solidago. The mines of *Agromyza platyptera* var. *coronata* should not be confused with those produced on the same host by *A. posticata*. In the latter species the larvae make large blotch mines having characteristic semicircular feeding marks within them, and, furthermore, the larvae abandon their mines to transform. The blotch mines of *A. platyptera* var. *coronata*, on the other hand, are much smaller and have no characteristic semicircular feeding marks within them, and the larvae transform within the mines. In the leaves of goldenrod the puparia are fastened securely to the inner surface of the mine by means of a pellet of frass; some of them are mounted on a little turret of frass.

The writer has reared this variety from *Aster novae-angliae*, *Solidago caesia*, *S. canadensis*, *S. latifolia*, *Verbena* species, and *Viola* species.

Melander (1913) records the variety from Massachusetts, New York, New Jersey, Pennsylvania, Illinois, Wisconsin, Louisiana, New Mexico, Colorado, Idaho, and Washington. This indicates a wide distribution in the United States. Loew (1864) records it from Cuba.

Larva.— Length 3.5 to 4 mm. Body yellowish white, nearly cylindrical, tapering gradually toward anterior end and slightly toward posterior end. Ambulatory setulae consisting of one row of strong setulae preceded by five or six rows of weak ones. Anterior spiracles semicircular, with eight or nine stigmatal slits. Posterior spiracles on rather prominent elevations from dorsal aspect of last segment. Spiracles in second instar strongly chitinized, pointed, with a single stigmatal slit.

Agromyza platyptera var. *jucunda* V.d.W.

1867 *Agromyza jucunda* V.d.W.
1879 *Oscinis malvae* Burgess
1913 *Agromyza platyptera* var. *jucunda* (V.d.W.) Melander

The habits of the variety *jucunda* are not well known to the writer. He has reared it from the leaves of *Ambrosia artemisiifolia* and *A. trifida.*

This variety has been found on the following food plants: *Althaea rosea, Ipomoea batatas, Ocynium basilicum* (Cardin); *Erigeron* species (Chittenden); *Malva rotundifolia* (Comstock, 1880 b); *Zinnia* species (Condit); *Aplopappus squamosa, Aster ericoides, Helianthus annuus, Solidago californica, Verbena* species, *Xanthium strumarium* (Coquillett, 1898); *Phaseolus vulgaris* (Cotton); golden glow (*Rudbeckia laciniata* var. *flore-pleno*) (Phillips, 1914).

The variety has a wide distribution, ranging from Canada south to Florida and west to California. It has been collected also in the West Indies.

Agromyza posticata Meig.

1830 *Agromyza posticata* Meig.
1872–74 *Agromyza virgaureae* Kaltb.
1895 *Agromyza terminalis* Coq.
1904 *Agromyza taeniola* Coq.

Agromyza posticata, although it is a common and widely distributed leaf-mining species, has not received much attention in the United States. In Europe it has been reported as mining in *Lycopsis arvensis* and in *Solidago virgaurea.* In America it mines in *Liquidambar styraciflua, Lobelia cardinalis, Medicago sativa,* and *Psedera quinquefolia,* and the writer has reared it from several species of aster and goldenrod.

The larvae of this species produce large blotch mines, sometimes covering almost the entire upper surface of the leaf. The mines are always on the upper surface and are scarcely visible from the lower side. When fresh they are greenish, with a whitish margin which is very characteristic. When they become dry they turn brown and the margin becomes pale brown. The larvae abandon their mines to transform.

These larvae should not be mistaken for the larvae of *A. platyptera* var. *coronata,* which also make blotch mines on the leaves of goldenrod. The larvae of *posticata* have a very systematic method of feeding on the leaves, and their feeding scars are regular and beautiful. As they feed, they swing the anterior end of the body from one side to the other, cutting an arc of a circle each time. They then move backward and repeat the operation, with the result that the finished mine shows groups of concentric arcs cut into the parenchyma of the leaf. The individual

scratches of the mouth hooks of the larvae can be seen in the fresh mines under the high power of the microscope.

This species has a limited number of food plants. The goldenrods and asters are apparently their preferred hosts. Of the known food plants of the species, two have been reported from Denmark — *Lycopsis arvensis* (Linnaniemi, 1913) and *Solidago virgaurea* (Brischke, 1880). The writer adds *Aster arvensis, A. laevis, A. novae-angliae, A. paniculatus, A. undulatus, Solidago bicolor, S. caesia, S. canadensis, S. juncea, S. latifolia, S. nemoralis,* and *S. serotina.*

The species ranges from Canada south to Tennessee and west to California.

Agromyza pusilla Meig.

1830 *Agromyza pusilla* Meig.
1830 *Agromyza pumila* Meig.
1830 *Agromyza strigata* Meig.
1830 *Agromyza exilis* Meig.
1830 *Agromyza orbona* Meig.
1830 *Agromyza pusio* Meig.
1830 *Agromyza puella* Meig.
1830 *Agromyza amoena* Meig.
1830 *Agromyza blanda* Meig.
1830 *Agromyza pascuum* Meig.
1857 *Phytomyza diminuta* Walker
1879 *Oscinis trifolii* Burgess
1885 *Oscinis brassicae* Riley

Agromyza pusilla is one of the commonest and most general feeders among the leaf-miners. Many families, genera, and species of plants have been reported as its hosts, and there are probably many others that still remain to be discovered. It is a decidedly variable species, and the types of mines which it produces on different hosts are of remarkable diversity.

Melander (1913) and Malloch (1913 a) have treated the *pusilla* group. Melander considers many of Meigen's species as varieties of *pusilla*, while Malloch considers them as synonyms of *pusilla.*

The shape of the mines produced by the larvae of this species varies considerably on different host plants, as already stated. The typical form is undoubtedly linear, and the species has therefore been given the name *serpentine leaf-miner.* The mines found on the leaves of nasturtium have all been linear. Usually but one or two mines are seen on a single leaf. On the Cruciferae the mines are linear, but since they are numerous and frequently interfere with one another, they often form blotch mines. On clover, the mines are at first linear but usually develop into blotches. On *Lactuca scariola* var. *integrata, Asclepias incarnata,* and *Sonchus oleraceus,* the mines are always of the blotch type. In the vicinity of Ithaca, New York, the larvae leave their mines to

transform. Webster and Parks (1913) believe that in arid and semi-arid regions the larvae transform within their mines, while in humid sections they abandon their mines to transform. It is interesting to note that on nasturtium the larva invariably retreats a short distance from the end of its linear mine and makes a slit parallel to the side of the mine in order to emerge.

This leaf-mining species has been recorded from fifty-five hosts, belonging to eighteen families as follows: Amaranthaceae, Asclepiadaceae, Capparidaceae, Caprifoliaceae, Chenopodiaceae, Compositae, Cruciferae, Euphorbiaceae, Geraniaceae, Gramineae, Labiatae, Leguminosae, Malvaceae, Plantaginaceae, Rosaceae, Scrophulariaceae, Solanaceae, and Valerianaceae. Twenty-two of the food plants are recorded from Europe, while the remainder are recorded from North America. The writer has reared the species from fifteen of these hosts. The food plants for *A. amoena, A. orbona,* and *A. strigata* are kept separate from those for *A. pusilla* in the food-plant index (page 174).

The species occurs both in Europe and in America and has a wide range of distribution. In America it ranges from Massachusetts south to Florida, and west to Washington and California.

Larva.— Length 4 to 4.5 mm. Body pale yellowish, subcylindrical. Ambulatory setulae small but evident, in five or six rows. Mouth hooks quadrangular, with three teeth. Posterior spiracles with six stigmatal slits.

Agromyza reptans Fall.

1823 *Agromyza reptans* Fall.

Agromyza reptans is a European species which Melander recorded from Idaho, Washington, and Oregon. Apparently its distribution in the United States is limited to the western part of the country. Malloch makes no mention of the species among his Agromyzidae of the eastern United States. In Europe it has been reported as a leaf-mining species. Brischke (1880) gives *Artemisia vulgaris* and *Potentilla anserina* as its food plants. Melander determined some material reared by the writer from Ambrosia as *Agromyza reptans* var. *subnigripes* Mall.

Agromyza reptans var. *subnigripes* Mall.

1830 *Agromyza nigripes* Schin. (*nec* Meig.)
1913 *Agromyza reptans* var. *subnigripes* Mall.

Malloch (1913 a) proposed *subnigripes* as a new name for *Agromyza nigripes* Schiner (*nec* Meig.). The writer, however, considers this form to be a variety of *A. reptans* Fall.

This variety has been reared repeatedly by the writer from various hosts — *Ambrosia artemisiifolia, A. trifida, Helianthus annuus, Urtica gracilis.* No other dipterous miners have been reared from *Urtica gracilis* or *Ambrosia trifida,* but several species have been reared from the other two food plants.

The larvae produce large mines on the upper surface of the leaves. On *Urtica gracilis* and *Helianthus annuus,* the mines are often inconspicuous. The larvae are voracious feeders and often mine the greater part of a leaf. The frass is sometimes scattered in small pellets, but more often the mine is filled with moisture and the frass becomes massed together, giving the mine a messy appearance. The mines usually become brownish when the leaves dry and shrivel. The full-grown larvae abandon their mines and fall to the ground to transform.

The following hosts have been recorded for this species: *Phragmites communis, Stellaria media* (Brischke, 1880); *Onobrychis sativa* (Karsch, 1883); *Medicago sativa* (Taschenberg, 1880); *Saccharum officinarum* (Vasiliev, 1914); *Ambrosia artemisiifolia, A. trifida, Helianthus annuus, Urtica gracilis* (the writer).

The species occurs in Europe and in America. In the United States it ranges from New Hampshire to Florida and west to Colorado.

Larva.— Length 3.5 to 4 mm. Body tapering gradually toward anterior end, widest just before posterior end and then tapering suddenly toward that end; segmentation not distinct. Ambulatory setulae conspicuous. Posterior segment produced into prominent stalks bearing posterior spiracles. Stigmatal plate with six short, subparallel slits, three on each side of median line.

Agromyza scutellata Fall. *sens str.*

1823 *Agromyza scutellata* Fall.
1823 *Agromyza flaveola* var. Fall.
1851 *Agromyza pictella* Thom.

Little is known concerning the occurrence of *Agromyza scutellata* in America. Malloch (1913 a) is not certain as to its specific distinctness from *A. reptans.*

In Europe the species has been reared and recorded as a leaf-mining form, under the name *Agromyza scutellata* Zett. Brischke (1880) says that the larva makes linear mines on the leaves of *Vicia cracca* and *V. faba.* It is doubtful whether the species has been bred in this country. McGregor (1914) mentions cotton as one of its host plants, but no doubt he had *Agromyza pusilla* in mind. In the collection in the United States National Museum there are specimens reared from *Carduus spinossimus* by T. H. Jones.

The species seems to occur chiefly in the western part of the United States. It has been recorded from Massachusetts, Illinois, Texas, Idaho, and Washington (Melander, 1913), from Claremont, California, and Williams, Arizona (Malloch, 1913 a), and from Utuado, Porto Rico (Coquillett).

Agromyza setosa Loew

1864 *Agromyza setosa* Loew

Agromyza setosa has often been collected, but few rearing records have been made. The writer has never reared nor collected this species

in the vicinity of Ithaca, New York. In other parts of the country, however, other writers report it.

Coquillett (1898) states that the mines made by *A. setosa* are serpentine and of varying lengths. At first they are visible only from the upper side of the leaf, but later they can be seen from the lower side, due to the yellowing of the parts beneath the mines. The mature larva transforms within the mine or clings to the surface of the leaf.

Two food plants, *Aster* species and *Zizania aquatica*, have been recorded from Europe for this species. The leaf-mining habit was first noted by T. Pergande and recorded by Coquillett (1898), who mentions two other host plants, chrysanthemum and strawberry. Malloch (1913 a), however, determined the larvae reared from these two plants as belonging to two new species, *A. maculosa* and *A. fragariae*, respectively.

The species ranges from Massachusetts south to Florida, and west to New Mexico and Colorado.

Agromyza ulmi n. sp.

Agromyza ulmi resembles *A. citreifrons* Mall., but the costa extends only to the third longitudinal vein, the cross-veins are not approximated, and there are four pairs of fronto-orbital bristles with smaller setae on the orbits adjacent to the eye margin.

The mines of *A. ulmi* can be readily found on the leaves of the American elm during the spring. They have been noticed at Ithaca and Florida, New York, and Arendtsville, Pennsylvania, and probably occur throughout the eastern part of the United States where elm is abundant.

The adults emerge from their overwintering puparia early in the spring, and by the middle of May the mines become very noticeable on the leaves. On May 20, 1920, the mines were numerous at Arendtsville, and by that time some of the larvae had matured and abandoned the leaves. They mature rapidly, and in a week or ten days no larvae can be found within the leaves. Apparently there is only one generation a year, as the larvae were not found later in the summer.

The mine is at first linear, and green in color, but later it broadens into a blotch and becomes brown in color. The frass is usually arranged in two dotted rows, one along each side of the mine. These rows of frass are very regular and follow the contour of the mine. The marks of the mouth hooks of the larva are visible as concentric arcs eaten in the parenchyma of the leaf. The mature larva escapes through a semicircular slit made on either the upper or the lower surface of the mine.

Adult.— Small. Front, face, cheeks, proboscis, palpi, antennae, legs, and halteres, yellow. Front slightly wider than width of either eye, protruding slightly at insertion of antennae, sides parallel; orbits concolorous with front, darkened on

upper third; four pairs of slender fronto-orbital bristles, and in addition a row of three or four small setae adjacent to eye margin; cheeks narrower in front than behind, about one-half eye height; one long, slender, oral vibrissa, and several smaller ones; setae of proboscis and palpi yellow; occiput and back of head cinereous; two rows of small setae on back of head adjacent to eye margin, extending only about halfway to lower margin of head; yellow of cheek extending back of eye, reaching about halfway to vertex, where it is intercepted by the cinereous color of the back of the head; eyes bare, rounded below and slightly angulate above; antennae entirely yellow; second segment with a prominent brown dorsal bristles; third segment scarcely longer than wide, about two and one-half times as long as second segment, minutely yellow pubescent, rounded at apex; arista nearly bare, brown, one and one-half times as long as third segment, yellow and slightly thickened at base. Mesonotum and scutellum cinereous; four pairs of dorso-central bristles; four regular rows of small setae between dorso-centrals, extending only about three-fourths the distance to scutellum; two or three rows of small setae outside dorso-centrals. Legs, including tarsi, yellow or light brown. Abdomen brown, slightly cinereous. Wings hyaline, veins brown; vein 2 slightly curving toward anterior margin of wing before entering costa; vein 3 nearly straight; vein 4 slightly curved, diverging only indistinctly from vein 3 at tip; second and third sections of vein 4 as 1:5; basal section of vein 5 slightly longer than distal section; costa extending only to third longitudinal vein; cross-veins somewhat approximated, about the length of the posterior cross-vein from each other; anterior cross-vein nearly one-half length of posterior cross-vein; fringe of calypteres pale yellow.

Agromyza viridula Coq.

1902 *Agromyza viridula* Coq.

Malloch (1913 a) records *Agromyza viridula* as a blotch miner on the leaves of red oak. Specimens bearing the label "Reared from blotch mine red oak leaf, June 20, 1912" are among Webster's material, collected by J. J. Davis at Lafayette, Indiana. No further rearing records have been received to substantiate this statement.

The species ranges from Massachusetts south to Georgia, and west to Wisconsin and South Dakota. It occurs also in the West Indies.

Agromyza n. sp. near *luctuosa* Meig.

A few larvae were bred from leaves of *Cyperus acuminatus* and sent to A. L. Melander, who determined them as a new species which has never been described.

Agromyza n. sp. near *pruinosa* Coq.

The larva of a new species of Agromyza was first discovered by I. M. Hawley when he was working on the hop insects of New York. This larva makes on the leaf a beautiful linear mine, which becomes much broadened as the larva continues to feed. The larva feeds in a methodical manner, resulting in regular, semicircular scratches where the parenchyma is removed. The frass is seen in a more or less definite line along each side of the mine, close to the edge. The larva abandons the mine to transform.

This species was found more difficult to rear than many of the other leaf-mining forms. Larvae collected in June formed their puparia by the first of July, but no adults issued until May and June of the following year. Due to the fact that the species was difficult to rear, the writer did not obtain enough material to warrant his describing it.

Genus **Cerodonta** Rondani

1835 *Odontocera* Macq.
1861 *Cerodontha* Rond.
1862 *Ceratomyza* Schin.

The genus Cerodonta is closely related to Agromyza. The species of this genus never have more than two scutellar bristles, and the costa always reaches to the fourth vein. The most distinguishing character is the thorn-like point on the third antennal joint.

Cerodonta femoralis Meig.

1838 *Agromyza femoralis* Meig.
1861 *Odontocera dorsalis* Loew

For a long time *Cerodonta dorsalis* Loew and *C. femoralis* Meig. were considered as two distinct American species. Aldrich (1918 a) made extensive collections of the two forms, and, after a careful study, came to the conclusion that *dorsalis* is no more than a pale-color variety of *femoralis*. Melander (1913) separated the forms on color characters. It appears that a low temperature during the pupal period produces darker colors in the adults, while a higher temperature produces lighter colors in the adults. It is possible that *femoralis* may be a color variety of the European form *denticornis* Panzer (1809). If this should prove to be the case, a large number of European names would be thrown into synonymy.

Cerodonta femoralis is well known in economic literature under the common names *corn leaf-miner, wheat leaf-miner, timothy leaf-miner,* and *spike leaf-miner*. Although the species is well known as a leaf-mining form, it is interesting to mention a record by Howard (1900), who reared it from human feces.

The life history and the habits of this species have been worked out in considerable detail by Luginbill and Urbahns (1916). The larvae mine in the leaves and sometimes in the stems of the young, tender plants. They often continue down to the axil of the leaf, and frequently come to rest in the leaf sheath. The mines are very narrow, whitish or pale green in color, and often much branched and crossing one another. The older mines become reddish in color. The mature larvae transform at the end of their mines, which often end in the leaf sheath.

There is another dipterous leaf-miner which works on corn and which at first sight might be confused with *C. femoralis*. This species,

Agromyza parvicornis (page 48), which has been called the *corn blotch leaf-miner*, makes much broader mines. They are linear, but always very broad, and the larva, in feeding, alternates from the lower to the upper surface of the leaf, making a discontinuous mine on each surface.

Aldrich has in his collection specimens reared from leaves of *Echinochloa crusgalli*, *Eragrostis* species, *Panicum capillare*, *P. sanguinale*, *Poa pratensis*, and *Syntherisma sanguinale*. Britton (1895) records the species from *Zea mays*. Luginbill and Urbahns (1916) record it (under the name *Cerodonta dorsalis* Loew) from *Andropogon sorghum*, *Avena sativa*, *Bromus carinatus*, *Dactylis glomerata*, *Eleusine indica*, *Elymus glaucus*, *Hordeum murinum*, *H. vulgare*, *Medicago sativa*, *Panicum dichotomiflorum*, *P. miliaceum*, *Phalaris minor*, *Secale cereale*, and *Setaria viridis*. Webster (1898) records it from *Phleum pratense*, *Triticum sativum*, and *Vigna sinensis*.. The writer has reared it also from leaves of *Panicum capillare* and *P. sanguinale*.

Larva.— Length 4 mm. Body dirty white in color, nearly cylindrical, slightly thicker at anterior end. Edges of segments armed with minute recurved locomotory spines. Anterior spiracles fan-shaped, slightly chitinized, with five stigmatal openings. Edges of second and third segments produced noticeably on ventral surface. Mouth hooks subtriangular in shape, with several teeth. Anal end abruptly truncate; posterior spiracles approximate, borne on dorsal aspect of last segment.

Genus **Napomyza** Van der Wulp

Some writers do not recognize the validity of the genus Napomyza, but the majority distinguish it by the presence of an outer cross-vein which is situated anterior to or directly below the inner cross-vein.

Hendel (1918) proposed two new genera, Pseudonapomyza and Phytagromyza, to include species formerly related to Napomyza. Napomyza, as well as Pseudonapomyza and Phytagromyza, is readily separated from Phytomyza by the presence of the posterior cross-vein and by the discal cell, which is complete but minute. Hendel separates Napomyza and Phytagromyza from Pseudonapomyza on the basis of the posterior basal cell being closed and not joined with the discal cell. In Napomyza both cross-veins stand before the termination of the auxiliary vein in the costa, and the small hairs on the orbits, between the orbital bristles and the eye margin, are bent forward. In Phytagromyza the posterior cross-vein stands beyond the termination of the auxiliary vein, and the small hairs on the orbits are bent upward or are absent.

Napomyza lateralis Fall.

1823 *Napomyza lateralis* Fall.

Little seems to be known concerning *Napomyza lateralis*. The species appears to be common in Europe, and has been placed as identical with *N. sonchi* R-D., and in part synonymous with *N. geniculata* Macq. Goureau (1851) gives the fullest account of its habits. He claims that the larva is very commonly found in Europe feeding on the parenchyma of

the leaf close to the lower epidermis, where it transforms to the pupa. He also figures a mine containing puparia, on a leaf of *Sonchus oleraceus*, which resembles mines found by the writer on that plant.

The food plants of the species are listed as follows: *Chrysanthemum leucanthemum* (Cooley [?]); *Pyrethrum inodorum* (Curtis, 1832); *Lonicera tatarica, Sonchus oleraceus* (Goureau, 1851).

Melander (1913) records the species from Europe, New Hampshire, Illinois, Missouri, Colorado, and Alaska, and Cooley has recorded it from Montana.

Genus **Paramyia** Williston

The genus Paramyia was erected by Williston (1908) to include a single species, *nigra nitens* (Loew). He mentions it as a probable leaf-mining genus, but no further records of its habits have been made, so far as the writer knows.

A revision of the North American species in Phytomyza Fallén

Phytomyza is closely related to Agromyza, but differs from that genus in having the anterior cross-vein situated near the base of the wing, and the posterior cross-vein wanting. The costa extends only to or slightly beyond the third vein, and the fourth and fifth veins are weak. The genus is close to Napomyza, but in that genus the posterior cross-vein is present, forming a minute discal cell.

The North American species of Phytomyza are comparatively few. Of the total of approximately a hundred species that have been described from various parts of the world, about forty occur in North America. Three of these, *Phytomyza praecox* Meig., *P. hieracii* Hendel, and *P. dasyops* Hendel, have been identified by the writer from material in the United States National Museum and are recorded for the first time from North America. Fourteen species are known by the writer to mine in leaves. The habits of the remainder are unknown, but it is very possible that all are leaf-miners. Sixty-three species have been reported from Europe as leaf-miners, making a total of seventy-seven species the larvae of which are known as leaf-miners.

This genus has been studied more carefully than have the other groups of leaf-mining Diptera, in order to make the present paper more comprehensive. A revision of the North American species of the genus has been made by the writer, as set forth in the following pages, and nine new species are included here.

With the exception of Agromyza, the genus Phytomyza contains the largest number of species of any group of Agromyzidae. Melander (1913) was the first to bring together the North American species. Hendel (1918) stands out prominently as a worker on Agromyzidae in Europe. The large number of new species which have recently been

discovered, and the increased knowledge of the habits of these flies, render the previous papers inadequate and have stimulated the present contribution. In making this study the writer had his own collection of species reared as leaf-miners. In addition he had access to the collections at the United States National Museum, containing the types of Malloch and of Coquillett, which were placed at his disposal through the courtesy of Dr. J. M. Aldrich, curator of the Diptera in the museum. He had also for comparison a very representative collection of European species of Phytomyza determined by Friedrich Hendel, and a few species determined by De Meijere, all of which are contained in the collections at the United States National Museum.

The larvae of this genus, so far as they are known, are all leaf-miners. It is the only genus among the Diptera that forms a natural group with such a habit. The food plants of most of the species are already known.

The limits of the genus are well defined. The writer includes those acalyptrate Diptera with the following characters: the costa extending to or only slightly beyond the third vein; the third vein ending far before the tip of the wing; the first, second, and third veins strong; the fourth and fifth veins weak; the sixth vein sometimes strong; the auxiliary vein usually parallel with the first vein but fading out at the tip; the anterior cross-vein situated near the base of the wing, never more than three times its own length from the division of veins 2 and 3; the posterior cross-vein always wanting; four dorso-central bristles; acrostichals present or absent; four scutellar bristles; one mesopleural and one sternopleural bristle; from three to five fronto-orbital bristles; the oral vibrissae usually strong; the cilia of the calypteres well developed and bushy; the third antennal segment usually rounded; the arista bare or pubescent, seldom approximating plumose.

Hardy (1849) attempted to subdivide the genus Phytomyza. He admitted that he could find no characters for separating the adults into groups, but resorted to the pupae, where, he said, the differences were sufficient to make two genera. He proposed the generic name *Chromatomyia* for the species with slipper-shaped puparia, whose larvae transformed within the leaves, and retained the name *Phytomyza* for the barrel-shaped puparia, whose larvae transformed in the ground. This classification is too artificial for general use, and has never been adopted by later workers.

Specific characters have been found in abundance. Color has been used occasionally, especially the color of the antennae, the legs, and the scutellum for the major groups. An attempt has been made to avoid color in most cases in the key. The separation of the black species on the characters *cinereous* and *shiny black* has always been difficult, because of subcinereous and subshiny species. The color on the back of

the head often forms a good character in descriptive work. In some species the yellow of the cheek continues back of the eye and unites with the yellow of the frontal orbits. The back edge of the head then has a narrow, or in some specimens a broad, yellow margin. At the same time the ocellar triangle is usually separated from the occiput by a narrow yellow band. When the yellow does not continue back of the head, the black of the back of the head intercepts it near the top of the eye. The number of rows of acrostichals, the number of fronto-orbitals, the small setae on the orbits adjacent to the eye margin, the row or rows of setae on the back of the head, and the color of the calypteres as well as the color of the wings in some species, have all been found good characters. The venation has been used considerably; the second, third, and fourth costal divisions, the divergence of veins 2 and 3, the location of the anterior cross-veins, and the curving of vein 4, have been found most valuable.

The following key separates the North American species of Phytomyza:

1. Front, face, and cheeks principally black or dark brown....2
   Front, face, and cheeks principally yellow....11
2. Front narrow, third antennal segment ending in a conspicuous point.... *acuticornis* Loew (=*lacteipennis* Mall., *nitidula* Mall.)
   Front broad, third antennal segment not ending in a conspicuous point....3
3. Frontal orbits whitish, front dark brown, cheeks one-sixth eye height, arista slender.... *orbitalis* Melander
   Frontal orbits black, concolorous with face and cheeks....4
4. Wings distinctly milky or tinged with brown....5
   Wings hyaline (slightly infumed in *nitida*)....6
5. Wings milky, cilia of calypteres brown, fourth vein straight, veins dark brown.... *nigrinervis* n. sp.
   Wings tinged with brown, cilia of calypteres white, fourth vein distinctly curved.... *nigripennis* Fall.

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6. Three pairs of fronto-orbital bristles....7
   Four pairs of fronto-orbital bristles....8
7. Cilia of calypteres brown, cheeks one-fourth eye height, acrostichals minute, wings slightly infumed.... *nitida* Melander
   Cilia of calypteres pale, cheeks one-half eye height, acrostichals not minute, wings hyaline.... *nigra* Meig.
8. Fourth vein distinctly curved, cilia of calypteres pale, sides of thorax black, pleural sutures not yellow.... *clematidis* Loew
   Fourth vein straight, cilia of calypteres brown, pleural sutures narrowly yellow....9
9. Mesonotum, scutellum, and orbits shiny black.... *obscurella* var. *nigritella* (Zett.) Melander
   Mesonotum, scutellum, and orbits cinereous....10
10. Second, third, and fourth sections of costa as 4:1:1½, arista three times length of third antennal segment.... *aquifolii* Gour.
    Second, third, and fourth sections of costa as 3½:1:2, arista not more than two and one-fourth times length of third antennal segment.... *ilicis* Curt. (=*ilicicola* Loew)

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11. Antennae entirely yellow....12
    Antennae black, or only basal segments yellow....19

12. Scutellum cinereous, not yellow in center 13
Scutellum yellow in center, sometimes cinereous on sides 16
13. Eyes densely hairy ..... *dasyops* Hendel
Eyes bare 14
14. Third antennal segment large, rounded, bare, no longer than broad ..... *flavinervis* n. sp.
Third antennal segment somewhat elongate, about one and one-half times as long as broad 15
15. Large species, fourth vein curving distinctly, second, third, and fourth sections of costa as 3 : 1 : 2½ ..... *genalis* Melander
Small species, fourth vein straight, second, third, and fourth sections of costa as 3 : 1 : 1½ ..... *flavicornis* Fall. (*nec* Melander)

16. Third antennal segment large, rounded, pilose 17
Third antennal segment small, bare 18
17. Body entirely yellow, with only a slight trace of brownish markings on mesonotum ..... *major* Mall.
Pleurae, abdomen, and legs yellow, mesonotum cinereous ..... *analis* Zett.
18. Three fronto-orbital bristles, cilia of calypteres brown, second, third, and fourth sections of costa as 3 : 1 : 1½ ..... *betae* Coq.
Four fronto-orbital bristles, cilia of calypteres white, second, third, and fourth sections of costa as 3 : 1 : 1 ..... *minuta* n. sp.

19. Femora yellow, legs chiefly yellow, scutellum usually yellow 20
Femora black or cinereous, knees only yellow 27
20. Mesonotum marked with three brownish vittae 21
Mesonotum cinereous, without vittae 24
21. Acrostichals present, three to four fronto-orbital bristles 22
Acrostichals absent, four fronto-orbital bristles ..... *trivittata* n. sp.
22. Cheeks nearly as broad as eye height ..... *clematívora* Coq.
Cheeks only one-half eye height 23
23. Fourth vein distinctly curved, scutellum cinereous on sides ..... *ranunculi* Schin.
Fourth vein straight, scutellum entirely yellow ..... *flava* Fall.

24. Mesonotum and scutellum cinereous ..... *nervosa* Loew
Mesonotum cinereous, scutellum yellow (in middle at least) 25
25. Three fronto-orbital bristles, third antennal segment entirely black 26
Four fronto-orbital bristles, palpi yellow, third antennal segment blackish only on distal half ..... *hieracii* Hendel
26. Palpi yellow, third antennal segment as long as broad ..... *flavo-scutellata* Fall.
Palpi black, third antennal segment quadrate, large ..... *praecox* Meig. (=*zetterstedti* Schin.)

27. Mesonotum with few or no acrostichals 28
Mesonotum with two or more rows of acrostichals 31
28. Antennae entirely black ..... *atricornis* Meig.
Basal segments of antennae yellow 29
29. Mesonotum, scutellum, and orbits shiny black ..... *aquilegiae* Hardy
Mesonotum, scutellum, and orbits cinereous black 30
30. Third antennal segment large, rounded, setae strong, two distinct rows of setae on outer margin of back of head ..... *chrysanthemi* Kowarz
Third antennal segment of medium size, one and one-half times as long as broad, setae not conspicuously strong, a single row of setae on outer margin of back of head ..... *plantaginis* R-D.

31. Two rows of acrostichals present 32
Three or more rows of acrostichals present 37

32. Antennae entirely black.....33
Basal segments of antennae yellow.....*subtenella* n. sp.
33. Third antennal segment large, arista much thickened and densely pubescent.... *crassiseta* Zett. (*nec* Hendel)
Third antennal segment of medium size, arista not thickened.....34
34. Second, third, and fourth sections of costa as 3: 1: 1 or 3: 1: 2, setae strong..35
Second, third, and fourth sections of costa as 3:1:3, setae slender..... *melanella* n. sp.
35. Three fronto-orbital bristles, third antennal segment densely pubescent..... *lactuca* n. sp.
Four to five fronto-orbital bristles, third antennal segment not densely pubescent 36
36. Four fronto-orbital bristles, second, third, and fourth sections of costa as 3: 1: 2.....*affinalis* n. sp.
Five fronto-orbital bristles, second, third, and fourth sections of costa as 3: 1: 1½.....*affinis* Fall.

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37. Fourth vein distinctly curved.....38
Fourth vein straight.....39
38. Sides of thorax, humeral callosities, yellow, a yellow spot on each side of mesonotum immediately in front of scutellum.....*bipunctata* Loew
Sides of thorax cinereous, pleural sutures only narrowly yellow..*albiceps* Meig.
39. Abdomen almost entirely yellow.....*bicolor* Coq.
Abdomen chiefly brown or cinereous.....*plumiseta* n. sp.

Phytomyza acuticornis Loew

1858 *Phytomyza acuticornis* Loew
1913 *Phytomyza lacteipennis* Mall.
1913 *Phytomyza nitidula* Mall.

Adult.— Front, face, cheeks, and palpi black, proboscis brown. Front about as wide as either eye, twice as broad as long, sides parallel; frontal stripe opaque; orbits shiny black; four or five pairs of weak fronto-orbital bristles; a single row of a few small setae on orbits adjacent to margin of eyes; ocellar triangle, occiput, and back of head shiny black; a prominent row of setae on outer edge of back of head, extending down hind margin of cheek. Antennae entirely black; third antennal joint ending in a prominent point; arista long and slender, about two and one-fourth times as long as third antennal segment, thickened on its basal fifth; a pale ring about arista just beyond basal thickening. Mesonotum and scutellum subshiny black; three pairs of dorso-central bristles, several irregular rows of acrostichals extending halfway to scutellum, similar setae outside dorso-centrals, and a strong propleural bristle. Legs chiefly black, tarsi brown. Abdomen black. Wings milky white, veins 1, 2, and 3 pale brown; veins 4 and 5 indistinct; second, third, and fourth sections of costa as 2: 1: 2½; anterior cross-vein about its own length from division of veins 2 and 3; halteres, calypteres, and cilia white.

Seventeen specimens in Dr. J. M. Aldrich's collection, from Treesbank and Aweme (Manitoba, Canada), Bismarck and Bottineau (North Dakota), and Martinez (California). Also, nine specimens in the United States National Museum, from Springer and Mesilla Park, New Mexico. Food plant unknown.

Phytomyza affinis Fall.

1823 *Phytomyza affinis* Fall.

For a long time the true identity of the species *Phytomyza affinis* in America has been uncertain. References to the species appeared in

American literature at first by mistake. Smulyan (1914) points out how Falconer (1887) mistook *P. chrysanthemi* Kowarz for *P. affinis* Fall. Melander (1913) records it authentically from this country for the first time, placing it in synonymy with *P. solita* Walker. Hendel (1918) has placed several European species in synonymy with *P. affinis*.

The habits of this species as a leaf-miner are well known in Europe. Its commonest food plants are *Chrysanthemum* species, *Eupatorium* species, *Helianthus annuus*, and *Medicago sativa*.

Adult.— Large, color yellowish. Front, face, and cheeks yellow, palpi black. Front one-half wider than either eye, sides distinctly narrowed below; orbits narrower below than above; four pairs of strong fronto-orbital bristles, the lowest pair in some specimens weak; a row of eight or nine prominent setae on orbits adjacent to eye margin, starting at upper fronto-orbital and continuing to lower fronto-orbital bristle; cheeks one-half eye height, slightly narrowed in front, antennal grooves slightly darkened; yellow of cheeks continuing back of eyes and joining yellow of orbits; ocellar triangle black; back of head black; a double row of prominent setae on outer edge of back of head, the uppermost seta long and conspicuous, one-half as long as the postvertical bristle. Basal segment of antennae yellow, second and third segments black; second segment with a single dorsal seta; third segment rounded, as long as broad, with a short, sparse, yellowish pile; arista two and one-half times as long as third antennal segment, not distinctly thickened at base. Mesonotum and scutellum cinereous; sides of thorax cinereous; pleural sutures and base of wing yellow; four pairs of strong dorso-central bristles; an occasional seta in line with dorso-centrals, and a few scattered setae outside dorso-centrals; two rows of acrostichals, with six to eight setae in a row; propleura, mesopleura, and sternopleura each with a strong bristle. Legs brown, subshiny; all knees pale yellow. Abdomen, in male, subshiny, dark brown, incisures broadly yellow, setae strong, black, genitalia yellow; abdomen similar in female, ovipositor brown to black. Wings hyaline; veins light brown, the costa as far as the humeral cross-vein, veins 1 and 2 to and slightly beyond the humeral cross-vein, and the humeral cross-vein, yellow; second, third, and fourth sections of costa as 4:1:1½; veins 2 and 3 parallel at tip of wing; veins 3 and 4 diverging at their tips; vein 4 straight, ending slightly beyond tip of wing; vein 6 not reaching wing margin; anterior cross-vein scarcely more than its own length from division of veins 2 and 3; halteres yellow; calypteres pale, cilia dark brown, bushy.

This species was compared with a male determined by Hendel, and also with specimens from Italy determined by Bezzi. The Italian specimens showed some difference in color; the sides of the mesonotum and the humeral callosities were chiefly yellow, there was a yellow spot on each side of the mesonotum immediately in front of the scutellum, and the ovipositor was shiny black. *P. nigricornis* Macq. is no doubt a synonym.

Phytomyza albiceps Meig.

1830 *Phytomyza albiceps* Meig.

Melander (1913) places *Phytomyza genualis* Loew in synonymy with *P. albiceps* Meig., but later, in manuscript notes, considers the inclusion of *genualis* as a mistake. *P. albiceps*, no doubt, has several European synonyms. Reh (1913) and Becker (Becker and Bezzi, 1905) consider *pisi* Kaltb. as identical with *albiceps*. Hendel (1918) places *geniculata*

Brullé, *sonchi* R-D., *fallaciosa* Brischke, *flavoantennata* Str., and *bipunctata* Loew, as synonyms. The last-named is probably a separate species.

The writer has found the larvae of *P. albiceps* at work from June to October. About the middle of September the mines of this species were not abundant on the various asters and goldenrods and other plants on which it works. Notes taken by the writer at Ithaca on October 23, 1915, indicate that the larvae were very abundant here at that time. On November 4 of the same year some flies issued from puparia formed in October. The majority of the flies winter as puparia and issue the following spring.

The mine is linear and varies considerably in its formation, according to the host on which it occurs. On Solidago and Aster it seldom curves upon itself, but on Symphoricarpos and Heracleum its linear nature often becomes considerably obscured by its twisted form. The injury always occurs on the upper surface of the leaf, although in most cases it is slightly visible from the lower surface also. The amount and the arrangement of the frass likewise vary considerably with the host. On Solidago and Aster the mine is whitish in color with a prominent central black frass line, strongly resembling the mines of the Nepticulidae; and in some specimens the frass terminates before the end of the mine, as in mines made by species of that family. The other extreme is found on Heracleum, where little or no frass is deposited within the mine although a few frass spots can sometimes be seen scattered throughout its length. On Symphoricarpos the mine is so different that it has the appearance of belonging to another species. On this host the frass may be scattered throughout the mine or arranged in a line down the center. At first the mine is greenish in color, but later it becomes brown with a distinct whitish margin. It is not flat, as on Solidago, but the upper epidermis is puckered and slightly elevated. On the majority of the host plants the larva abandons the leaf to transform, making its exit through a semicircular slit on the lower side of the leaf. On Symphoricarpos, however, the larva transforms within the leaf at the side or the end of the mine. This difference in habit may be due to the exceptional thickness of the leaves of this host.

The following list includes some of the food plants that have been recorded for this species: *Aconitum napellus, Chrysanthemum inodorum* (Brischke, 1880); *Centaurea jacea* (Kaltenbach, 1872–74); *Ballota* species, *Chrysanthemum leucanthemum, Cirsium oleraceum, Leonurus cardiaca, Lithospermum arvense, Papaver rhoeas, Pimpinella magna, Sambucus* species, *Senecio jacobaea, Sonchus oleraceus, Taraxacum* species, *Valerianella* species (Karsch, 1883); *Arctium lappa, Atriplex* species, *Cirsium arvense, Helianthemum* species, *Senecio vulgaris* (Leo-

nardi, 1900); *Lathyrus* species (Reh, 1913); *Aster novae-angliae, A. paniculatus, A. undulatus, Heracleum lanatum, Symphoricarpos racemosus, Tanacetum vulgare* (the writer).

Both in Europe and in America, *P. albiceps* appears to be a common and widely distributed species. Melander (1913) records it from Washington, D. C., from Massachusetts, New York, Oregon, Washington, California, and Idaho, and from Ontario. The writer has reared it repeatedly at Ithaca and Florida, New York. Dr. J. M. Aldrich has specimens in his collection from La Fayette, Indiana, from Berkeley, California, from Knoxville, Tennessee, and from Mount Rainier, Washington.

Larva.— Length 4.5 to 5 mm. Body subcylindrical, slightly thickened and tapering gradually toward anterior end. Anterior spiracles with eight to ten slits. Mouth hooks quadrangular, with three teeth. Posterior spiracles with fifteen to eighteen slits.

Adult.— Medium-sized, color yellow. Front, face, cheeks, proboscis, and basal segments of antennae yellow, palpi black. Front about the width of either eye, sides slightly converging below; three pairs of fronto-orbital bristles; a sparse row of about five small setae on orbits adjacent to eye margin, starting at or near upper fronto-orbital and continuing to lower fronto-orbital bristle; cheeks one-half eye height; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle dark brown, separated from occiput by a narrow yellow band; a row of rather prominent setae on outer margin of back of head, extending down along hind edge of cheeks. Basal segments of antennae yellow or slightly infuscated; third segment black, one-half longer than wide, covered with a dense yellowish pile; arista two and one-fourth times as long as third antennal segment, thickened on basal fourth. Mesonotum and scutellum cinereous, slightly subshiny; sides of thorax subshiny; pleural sutures broadly yellow; four pairs of dorso-central bristles, the anterior pair slightly the smallest; two irregular rows of setae outside the dorso-centrals; three irregular rows of acrostichals, reaching three-fourths the distance to scutellum. Legs brown; knees pale yellow. Abdomen, in female, subshiny black, only the last incisure yellow, ovipositor shiny black, twice the length of last abdominal segment; in male, subshiny brown, incisures narrowly yellow. Wings hyaline; second, third, and fourth sections of costa as 4:1:1½; vein 2 parallel with vein 3 throughout its first half, then bulging toward anterior margin of wing, finally ending parallel with vein 3; vein 3 nearly straight; vein 4 straight; vein 5 bending gently into margin of wing; halteres yellow; cilia of calypteres brown.

European material determined by Hendel was examined, and was found to differ in the following respects: the humeral callosities and the sides of the thorax were broadly yellow, and there was a yellow spot on each side of the mesonotum immediately in front of the scutellum.

Phytomyza analis Zett.

1848 *Phytomyza analis* Zett.

The writer is not familiar with *Phytomyza analis*. Melander (1913) records the species from Indiana. Hendel (1918) recognizes it as a valid species and places *Phytomyza terminalis* Becker and *P. rufescens* v. Ros. in synonymy. He has given the following descriptive notes, which enhance Zetterstedt's meager description of the species:

Front pale yellow to reddish yellow, cheeks about one-half eye height, a row of small setae on orbits adjacent to the eye margin; basal segments of antennae entirely yellow, third segment yellow at base, brown at tip; mesonotum black faintly covered with brownish dust, not yellow in front of scutellum, four dorso-central bristles present; pleurae spotted with black; abdomen yellow; wings hyaline third longitudinal vein straight, fringe of calypteres blackish.[2]

Phytomyza aquifolii Gour.

1851 *Phytomyza aquifolii* Gour.
1862 *Phytomyza ilicis* Kaltb.

Hendel (1918) places *Phytomyza aquifolii* Gour. in synonymy with *P. ilicis* Curt. (*ilicicola* Loew). The writer has examined specimens of *aquifolii* Gour. in the United States National Museum, and found them to be distinct from *ilicis* Curt. *P. aquifolii* is a European species which has recently been introduced into America. Weiss (1916 b) reported it for the first time in this country, stating that it mined leaves of English holly and also holly imported from Europe (Holland). It has also been intercepted at San Francisco, California, on holly imported from Holland. In Europe it is a well-known species and mines *Ilex aquifolium.*

From the diagrams made by Goureau (1851), it appears that the mines of this species are slightly different from those produced by *P. ilicis* Curt. The mines of *P. aquifolii* are oval in outline, without tracings or indications of a linear part; while the larvae of *P. ilicis* make script-like tracings on the leaf before starting their blotch mines. In both species the larvae transform within the mine.

Larva.— Length 4 mm. Body widest at anterior end. Ambulatory setulae minute. Anterior spiracles on distinct projections of body, with six or more radiating stigmatal slits. Antennae and sensory papillae approximated. Mouth hooks with two teeth. First segment with a fleshy tentacle dorsally. Two hooks at each side of oral opening, and ten or more chitinous rings surrounding oral opening. Posterior spiracles similar to anterior ones, with five to nine stigmatal slits.

Adult.— Large, color blackish. Front, face, and cheeks black; palpi and proboscis yellow. Front as wide as either eye; frontal stripe yellowish opaque; orbits darkened, subshiny; four pairs of fronto-orbital bristles; a single row of small setae on orbits adjacent to eye margin; a single row of prominent setae on outer edge of back of head; cheeks about one-fourth eye height; ocellar triangle black, continuous with the black occiput. Antennae entirely black; third segment slightly elongate; arista about three times as long as third antennal segment, microscopically pubescent, slightly thickened on basal fifth. Mesonotum and scutellum subshiny black, lightly dusted; four pairs of dorso-central bristles, the anterior pair the smallest; six to seven irregular rows of acrostichals, extending almost to scutellum; three to four rows of small setae outside dorso-centrals; pleural sutures narrowly yellow. Legs entirely dark brown. Abdomen shiny black. Wings hyaline, vein 1 pale yellow to cross-vein; second, third, and fourth sections of costa as 4:1:1½; vein 2 diverging distinctly from vein 3 at margin of wing; vein 3 ending about the same distance before wing tip as vein 4 ends beyond wing tip; anterior cross-vein about twice its length from division of veins 2 and 3; halteres yellow; cilia of calypteres dusky.

[2] Author's translation.

Phytomyza aquilegiae Hardy (*P. nigra* Curtis, according to Hendel, 1918)

1849 *Phytomyza aquilegiae* Hardy

Phytomyza aquilegiae was first recorded from the United States by Britton (1895), who found it mining on several species of Aquilegia in Connecticut. The species is injurious on cultivated columbine, both in greenhouses and in flower gardens.

The larvae produce very conspicuous and rather beautiful linear mines. These occur only on the upper side of the leaf, although the thinness of the leaf makes them slightly visible from the lower surface also. The mines are whitish in color, even after they have become dried, are linear, and are very tortuous, with black frass spots. Hardy (1849) says the larvae make blotch mines. The writer has found this true in some instances when the miners have turned upon themselves, thus producing a blotch; but a linear mine is more typical.

The full-grown larvae abandon their mines to transform. They make their exit through semi-circular slits at the end of the mines, on the under surface of the leaf. Some of the puparia remain attached to the surface of the leaf near the exit holes, while others fall to the ground. The puparia are exceptionally small, are football-shaped and dark-colored, and look very much like seeds. No doubt they are protected from destruction by their resemblance to seeds.

The adults, like those of many other Agromyzidae, make circular punctures in the leaves with their ovipositors, and through these punctures they suck the juices of the plant. The punctures later become whitish in color and very conspicuous.

The writer has reared the species from *Aquilegia canadensis* and *A. vulgaris.* Hardy (1849) also records it from *A. vulgaris,* and Britton (1895) from *A. canadensis.* Coquillett (1898) records it from the garden nasturtium (*Tropaeolum* species).

There are sufficient records to show that this miner is very generally distributed throughout the United States. It has been recorded from Connecticut, Illinois, and Idaho (Melander, 1913), from Ithaca and Tarrytown, New York (the writer), from Inwood and New Brunswick, New Jersey (Strong, 1897), and from Washington, D. C. (Coquillett, 1898).

Adult.— Color blackish. Front, face, and cheeks yellow. Front wider than either eye; orbits shiny black, about half as wide as frontal stripe; frontal stripe entirely yellow; three pairs of fronto-orbital bristles; a sparse row of small setae on orbits adjacent to eye margin; cheeks about one-half eye height; edges of face and oral margin black, cheeks and face otherwise yellowish; ocellar triangle black, continuous with occiput which is shiny black; an indistinct row of small setae on outer edge of back of head, continuing down hind edge of cheeks. Basal two segments of antennae yellowish, strongly infuscated; third segment black, large, rounded, about as long as broad; arista about one and one-half times as long

as third antennal segment, microscopically but rather distinctly plumose, thickened on basal third. Mesonotum and scutellum shiny black; pleural sutures very narrowly yellow; four pairs of slender dorso-central bristles, the anterior pair the weakest, dorso-centrals preceded by a few small setae; acrostichals absent. Legs dark brown; knees but slightly paler. Abdomen, in both male and female, shiny black. Wings hyaline, veins brown, costa and vein 1 pale yellow about halfway to humeral cross-vein; second, third, and fourth sections of costa as 4:1:2; anterior cross-vein about its own length from division of veins 1 and 2; halteres yellow; calypteres and cilia pale.

Phytomyza atricornis Meig.

1838 *Phytomyza atricornis* Meig.

Adult.— Color yellow. Front, face, cheeks, and proboscis yellow. Front about the width of either eye, slightly longer than broad; orbits darkened on their upper outer angles; cheeks one-half eye height; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle black subshiny, continuous with occiput; three pairs of fronto-orbital bristles; a sparse row of about six forward-projecting setae on orbits adjacent to eye margin; occiput and back of head cinereous black; a single row of small setae on outer edge of back of head, a few scattered setae adjacent to this row. First and second antennal segments black subcinereous; third segment black, quadrate, slightly longer than broad; arista almost bare, scarcely more than twice as long as third antennal segment, distinctly thickened on basal third. Mesonotum, metanotum, and scutellum cinereous, sides of thorax cinereous, pleural sutures narrowly yellow; four pairs of strong dorso-central bristles; a few small setae preceding dorso-centrals; a few small setae on humeral callosities; acrostichals absent; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Femora, tibiae, and tarsi subshiny black; all knees distinctly yellow. Abdomen, in male, yellow on sides at base, segments subshiny black, incisures narrowly yellow. Wings transparent; second, third, and fourth sections of costa as 4:1:2½; veins 2 and 3 subparallel; vein 4 nearly straight; vein 5 bending gently into margin of wing; anterior cross-vein about its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia brown.

Dr. Aldrich has in his collection one specimen from Tennessee Pass, Colorado, which was compared with two specimens determined by Hendel. Hendel places many European species, as well as *P. chrysanthemi* Kowarz, in synonymy with *P. atricornis* Meig. The writer believes that *P. chrysanthemi* Kowarz is a distinct species.

Phytomyza betae Coq.

1900 *Phytomyza betae* Coq.

Adult.— Small, color yellowish. Front, face, cheeks, antennae, and palpi, entirely yellow. Front as wide as either eye, about as long as broad; three pairs of fronto-orbital bristles; no small setae on orbits adjacent to eye margin; keel on face rather distinct; cheeks one-half eye height, as wide in front as behind; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle brown subshiny, continuous with occiput; a single row of small setae on outer edge of back of head. Antennae entirely yellow; third segment small, rounded; arista dark brown, about three times length of third antennal segment, slender on apical part but distinctly thickened on basal third. Mesonotum subshiny brown; scutellum yellow in center, darkened on sides; sides of thorax yellow; sternopleura brown; four pairs of dorso-central bristles, the anterior pair scarcely distinguishable from the acrostichals; two rows of acrostichals. Femora and tibiae yellow; tarsi brown. Abdomen, in male, subshiny

brown, incisures yellow, sides, especially at base, yellow; similar in female, ovipositor shiny black, scarcely as long as last segment. Wings hyaline, rounded at tip; second, third, and fourth sections of costa as 3:1:1½; veins 2 and 3 nearly parallel at tip of wing; veins 3 and 4 slightly diverging at tip; anterior cross-vein about three times its length from division of veins 2 and 3; two prominent setae on costa before humeral cross-vein; halteres yellow; cilia of calypteres dusky.

Described from four specimens in the United States National Museum, including the type.

Phytomyza bicolor Coq.

1902 *Phytomyza bicolor* Coq.

Adult.— Large, color yellow. Front, face, cheeks, and proboscis yellow, palpi black. Front as broad as either eye, width about equal to length; frontal stripe opaque, orbits subshiny; four pairs of strong fronto-orbital bristles, in some specimens an additional smaller bristle; a row of small setae on orbits adjacent to eye margin; cheeks slightly infuscated, nearly one-half eye height; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle black, continuous with occiput; outer margin of back of head with two or three rows of small setae. Basal segments of antennae dark brown; third segment black, rounded, as long as broad, nearly bare; arista twice length of third antennal segment, microscopically but distinctly pubescent, almost plumose. Mesonotum and scutellum subshiny to cinereous black; pleural sutures yellow; sides of thorax cinereous subshiny; four pairs of dorso-central bristles, the anterior pair the smallest; two or three rows of small setae outside dorso-centrals; five to six irregular rows of acrostichals reaching more than three-fourths the distance to scutellum; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Femora, tibiae, and tarsi dark brown, femora slightly cinereous. Abdomen, in male, with basal six segments conspicuously yellow, seventh segment and genitalia brown, setae black; in female, basal five segments entirely yellow, sixth segment one-half wider than fifth, subshiny brown on basal half, yellow on incisure, ovipositor one and one-half times as long as sixth abdominal segment, shiny black. Wings hyaline, tinged with brown; base of wing, including costa, to humeral cross-vein, yellow; vein 1 and humeral cross-vein also yellow; second, third, and fourth sections of costa as 4:1:1½; veins 2 and 3 subparallel, bulging toward anterior margin of wing before terminating; vein 4 nearly straight; anterior cross-vein twice its length from division of veins 2 and 3; costa with two prominent setae before humeral cross-vein, the longer one pointing inward, the shorter one pointing outward; halteres yellow; calypteres pale, cilia brown, bushy.

Species compared with European material and found not to be a synonym of *Phytomyza abdominalis* Zett., as Hendel thought it might be.

Phytomyza bipunctata Loew

1858 *Phytomyza bipunctata* Loew

The writer is not certain that this is a distinct species, although Melander (1913) records it from Idaho and Washington. Hendel (1918) places it as a synonym of *Phytomyza albiceps* Meig., along with *P. flavoantennata* Strobl, *P. fallaciosa* Brischke p.p., *P. geniculata* Brullé, and *P. sonchi* R-D. A detailed description is given by Loew (1858). It is apparently a color variety of *P. albiceps* Meig., with the anterior humeral callosities and the sides of the thorax broadly yellow.

Phytomyza chrysanthemi Kowarz

1891 *Phytomyza chrysanthemi* Kowarz

Hendel (1918) places the species *Phytomyza chrysanthemi* Kowarz in synonymy with *P. atricornis* Meig. The writer has examined specimens of *atricornis* Meig. determined by Hendel, and is of the opinion that the two species are distinct. Smulyan (1914) has pointed out the confusion of *P. chrysanthemi* Kowarz with *P. affinis* Fall. and *P. lateralis* Fall. as it appears in the literature of the genus. As a matter of fact, *P. chrysanthemi* is distinct from the two latter species, but it is closely related to *P. plantaginis* R-D. The original descriptions are not sufficient to separate these two species.

P. chrysanthemi has been reared from a large number of closely related plants. The majority of the host plants belong to the Compositae. Some of the hosts are as follows: *Helianthus californicus, Pisum sativum* (Aldrich); *Chrysanthemum frutescens* (Coquillett, 1895 b); *Chrysanthemum parthenifolium, Eupatorium* species, *Gazania* species, *Helianthus multiflorus, Senecio cruentus* (cineraria) (Falconer, 1887); nasturtium, *Papaver* species (Goureau, 1851); *Ambrosia artemisiifolia, Antennaria plantaginifolia, Bidens frondosa, Chrysanthemum indicum, C. leucanthemum, C. morifolium, C. sinense, Daucus carota, Helianthus annuus, Solidago nemoralis, Tanacetum vulgare, Taraxacum officinale* (Smulyan, 1914).

Collecting and rearing records for this species indicate that it is widely distributed. It has been recorded from Canada to Florida, and westward to California.

Larva.— Length 3.5 to 4 mm. Body subcylindrical, slightly thickened just before anterior end, truncate at posterior end. Ambulatory setae very minute, scarcely visible even under compound microscope. Anterior spiracles approximated at base, clublike, with nine to ten stigmatal slits. Third segment notched behind spiracles. Mouth hooks quadrangular, with three teeth. Posterior spiracles approximated and projecting but slightly. Stigmatal plate with nine slits arranged in a semicircle.

Adult.— Color yellowish. Front, face, and cheeks yellow, palpi black. Front slightly broader than either eye, about as long as broad, sides parallel; three pairs of fronto-orbital bristles; a row of small setae on orbits adjacent to eye margin, projecting forward and reaching from upper orbital to slightly below lower orbital bristle; cheeks hardly one-half eye height; yellow of cheeks extending back of eyes and joining yellow of orbits; ocellar triangle shiny, dark brown, separated from occiput by a narrow yellow band; orbits not darkened above; occiput and back of head dark brown; outer margins of head with a single row of setae. Basal two segments of antennae yellow; third segment black, rounded, slightly shorter than broad; arista about twice length of third antennal segment, almost bare, thickened on basal third. Mesonotum and scutellum cinereous; sides of thorax cinereous; pleural sutures narrowly yellow; base of wings yellow; four pairs of strong dorso-central bristles, preceded by a few small setae; acrostichals rarely developed, at most two irregular rows, with from three to four setae in a row. Legs brown cinereous; knees broadly yellow. Abdomen, in both male and female, dark brown, incisures distinctly yellow; in female, the last segment with a broad

incisure. Wings hyaline; second, third, and fourth sections of costa as 4:1:2½; veins 2, 3, and 4 straight; vein 6 almost reaching wing margin; anterior cross-vein about twice its length from division of veins 2 and 3; costa with two strong setae before humeral cross-vein, the basal, longer one pointing inward; halteres yellow; calypteres and cilia pale.

Phytomyza clematidis Loew

1863 *Phytomyza clematidis* Loew

Phytomyza clematidis has been reared from Clematis by Loew, and has been reported several times from this country. The writer has never reared the species, but he has received leaves from Newark, New Jersey, which undoubtedly were mined by the larvae. The mines are linear and very long. Loew (1863) found the larvae mining the leaves of Clematis at Washington, D. C. Melander (1913) records the species from Ontario, Canada. Aside from these meager notes, the habits of the species are unknown.

Dr. Aldrich has in his collection specimens from La Fayette, Indiana, from Moscow, Idaho, and from Toronto, Canada. The European *P. clematidis* Kaltb. may be a synonym, but *P. clematadi* Watt is apparently another species.

Adult.— Small, color black. Front, face, cheeks, antennae, and palpi black, proboscis yellow. Front as broad as or slightly broader than width of either eye, sides nearly parallel; frontal stripe opaque; orbits shiny black; four pairs of fronto-orbital bristles; a row of small, inconspicuous setae on orbits adjacent to eye margin; cheeks narrow, about one-third eye height; ocellar triangle and occiput shiny black. Antennae entirely black; third segment rounded, about as long as broad; arista two and one-half times as long as third antennal segment, nearly bare. Mesonotum and scutellum shiny black, pleural sutures not yellow; four pairs of dorso-central bristles, the anterior pair the smallest; four or five irregular rows of acrostichals, extending nearly to scutellum. Legs shiny black; knees paler. Abdomen shiny black. Wings hyaline; second, third, and fourth sections of costa as 4:1:2; vein 4 diverging from vein 3, curving slightly into costa a little beyond wing tip; vein 5 ending more than one-half distance from base to tip of wing; anterior cross-vein only slightly more than its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia pale.

Phytomyza clematívora Coq.

1898 *Phytomyza clematívora* Coq.

There is nothing to indicate that *Phytomyza clematívora* is a leaf-mining form. Coquillett (1898) records the species from Brownsville, Texas, on Clematis, but says nothing concerning its habits. It is a well-defined species, and, judging from the habits of the other species of Phytomyza, it can very well be included among the leaf-miners.

Hendel (1918) thought *P. clematívora* Coq. might be a synonym of *P. vitalbae* Kaltb. The two species are, however, quite distinct.

Adult.— Small, color yellow. Front, face, cheeks, scutellum, pleurae, palpi, proboscis, halteres, and legs, yellow. Front broader than either eye; cheeks almost as broad as eye height; three pairs of fronto-orbital bristles, the upper two pairs near inner margin of orbits, the lowest pair near outer margin of orbits; a row of

minute setae on lower part of orbits adjacent to eye margin. Basal two segments of antennae yellow; third segment black, slightly longer than broad. Markings of mesonotum reddish, subshiny; a quadrate yellow spot immediately in front of scutellum, two yellow lines extending from this spot to front edge of mesonotum dividing it into three reddish brown vittae; four pairs of dorso-central bristles; two rows of small acrostichals. Abdomen, in male, largely yellow; segments reddish brown, subshiny; incisures broadly yellow; last two segments entirely yellow. Wings hyaline, rather short, rounded at apex; second, third, and fourth sections of costa as 3½: 1: 3; veins 3 and 4 diverging prominently, vein 4 nearly straight; halteres yellow; calypteres and cilia pale.

Described from two specimens in the United States National Museum, reared from Clematis by Chittenden.

Phytomyza crassiseta Zett.

1860 *Phytomyza crassiseta* Zett.

Adult.— Medium-sized, color yellowish. Front, face, cheeks, and proboscis yellow, palpi black. Front as broad as either eye, slightly longer than broad, sides parallel; three pairs of fronto-orbital bristles; a row of four or five small setae on orbits adjacent to eye margin; cheeks one-fourth eye height; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle black, subshiny, continuous with occiput; back of head black subcinereous; a row of minute setae on outer edge of back of head, continuing down hind margin of cheek. Antennae entirely black or the basal segment infuscated; third segment large, subquadrate, covered with a yellowish pile; arista one and one-half times as long as third antennal segment, distinctly thickened throughout its entire length, and densely pubescent. Mesonotum, scutellum, and sides of thorax cinereous; pleural sutures narrowly yellow, base of wings also yellow; four pairs of strong dorso-central bristles; two rows of acrostichals, with three or four setae in a row; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs concolorous brown, slightly cinereous; knees distinctly yellow. Abdomen, in female, subshiny, dark brown, incisures narrowly yellow; last incisure broader than others; ovipositor shiny black, about twice as long as last segment. Wings hyaline; second, third, and fourth sections of costa as 3:1:3; veins 2 and 3 curved slightly toward anterior margin; veins 4 and 5 straight; vein 6 reaching almost to margin of wing; anterior cross-vein scarcely more than its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia pale.

Described from four females in Dr. Aldrich's collection, from Michigan City and La Fayette, Indiana. There are also specimens from San Francisco, California, bred from the leaves of Dahlia. This species was compared with European material determined by Hendel, and was found to differ in the following respects: Hendel's *P. crassiseta* has the basal antennal segment distinctly yellow, the second antennal segment proportionately longer, the third segment proportionately smaller, the arista more slender and thickened on the basal half only, vein 5 curving slightly into the wing margin, the cheeks nearly one-half the eye height, the sides of the front not straight but narrowed above by the curving of the eye margin. The writer believes that Hendel did not have the true *crassiseta* of Zetterstedt.

Phytomyza dasyops Hendel

1918 *Phytomyza dasyops* Hendel

Adult.—Small to medium-sized, 3½ mm. long, color yellow. Front, face, cheeks, proboscis, palpi, antennae, femora, tibiae, and pleural sutures, narrowly yellow; occiput and ocellar triangle black; upper part of orbits black; eyes distinctly yellow, beset with dense pubescence; antennal grooves shallow, yellow. Front as broad as width of either eye; orbits one-fourth width of front; one distinct and

several small vibrissae; four pairs of fronto-orbital bristles; two or three rows of minute setae on orbits adjacent to eye margin; cheeks as broad as eye height. Antennae entirely yellow; third segment slightly infuscated; second segment with several small black setae and a long dorsal seta; arista scarcely twice as long as third antennal segment, distinctly pubescent, almost plumose, the pubescence becoming shorter at tip. Mesonotum and scutellum cinereous black, with a brownish tinge; humeral callosities with numerous small setae; four pairs of dorso-central bristles; several rows of small setae outside dorso-centrals; several irregular rows of acrostichals. Abdomen, in female, dark brown; incisures distinctly and broadly yellow, the yellow narrow in the middle, and broad on the sides, of the segments; incisure of last segment very broad; ovipositor dark brown; under side of abdomen yellow; abdominal setae coarse, black. Wings long, tapered toward tip; second, third, and fourth sections of costa as 3:1:1½; veins 1, 2, 3, and 5 strong, vein 4 weak; vein 3 ending somewhat before tip of wing; vein 4 ending in tip of wing; vein 5 ending in margin two-thirds of distance from base to tip of wing; vein 6 almost reaching margin of wing; anterior cross-vein more than its own length from division of veins 2 and 3.

Described from one female specimen, from Yakutat, Alaska, collected by Dr. Aldrich.

Phytomyza flava Fall. (*P. ranunculi* R-D., according to Goureau, 1851)

1823 *Phytomyza flava* Fall.

The species *Phytomyza flava* is well known as a leaf-miner in Europe, where it has been recorded from Germany, France, and Denmark. In America it is little known. Melander (1913) records it from Washington. Dr. Aldrich has in his collection specimens from La Fayette and Moscow, Indiana, and from Toronto, Canada.

The writer is not familiar with the habits of this species. Goureau (1851) states that the larvae mine the leaves of *Ranunculus acris*, making linear mines which often cross at intervals, forming a series of chambers; and that the full-grown larva transforms at the end of its mine.

No hosts are known in America, but the following food plants have been recorded from Europe: *Chaerophyllum tremulum*, *Ranunculus bulbosus*, *R. langinosus*, *R. repens* (Brischke, 1880); *Scolopendrium vulgare* (Glover, 1874); *Ranunculus acris* (Goureau, 1851); *Ranunculus flammula* (Karsch, 1883).

Adult.— Medium-sized to large, color chiefly yellow. Front, face, cheeks, and proboscis yellow, palpi black or dark brown. Front one-half wider than either eye, considerably broader than long, sides converging below; frontal stripe and orbits concolorous yellow; three pairs of fronto-orbital bristles, the uppermost pair weak; a row of weak setae on orbits adjacent to eye margin, extending from the upper to slightly below the lower fronto-orbital bristles; two to three irregular rows of prominent setae on outer margin of back of head, extending down hind margin of cheeks; cheeks less than one-half eye height, slightly narrowed in front; yellow of cheeks extending back of eyes and joining yellow of orbits; ocellar triangle shiny, dark brown, separated from occiput by a narrow yellow line; occiput and back of head dark shiny black. Basal two segments of antennae yellow; second segment with a strong dorsal black seta and a few scattered smaller setae; third segment black, rounded, slightly longer than broad; arista almost bare, two and one-half times as long as third antennal segment, distinctly

thickened on basal third. Mesonotum and scutellum chiefly yellow; mesonotum marked by three cinereous reddish vittae; the middle vitta starting on cephalic edge of mesonotum and continuing three-fourths the distance to scutellum, leaving a quadrate yellow spot in front of scutellum; the lateral vittae not reaching anterior margin of mesonotum, but extending almost to posterior edge of mesonotum; scutellum entirely yellow; sides of mesonotum and pleural suture almost entirely yellow; four pairs of strong dorso-central bristles arising from the yellow bands separating the cinereous vittae; two rows of acrostichals, with about three or four setae in a row; three to four small setae outside dorso-centrals, and a row of four or five prominent setae preceding dorso-centrals. Legs entirely yellow. Abdomen, in female, entirely yellow; ovipositor shiny black, twice as long as last abdominal segment. Wings hyaline; second, third, and fourth sections of costa as 5:1:3; vein 2 curving distinctly toward costal margin of wing in latter part of its course, but ending parallel with vein 3 at margin of wing; vein 4 straight; vein 5 curving slightly into margin of wing; vein 6 reaching almost to margin of wing; halteres yellow; calypteres and cilia pale.

Markings of mesonotum more cinereous and darker in the European material.

Phytomyza flavicornis Fall.

1823 *Phytomyza flavicornis* Fall.

Adult.— Color yellow. Front, face, cheeks, antennae, and proboscis yellow, palpi dark brown. Front nearly twice the width of either eye, about as broad as long; orbits and frontal stripe concolorous, orbits slightly darkened on upper outer edges; four pairs of strong fronto-orbital bristles; a row of seven or eight prominent but small setae on orbits adjacent to eye margin; front protruded somewhat at insertion of antennae; keel in center of face rather prominent; cheeks about as broad as eye height; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle shiny black, continuous with the dark-colored occiput; a sparse but distinct row of setae on outer edge of back of head, a second row of much smaller setae adjacent to this one. Antennae entirely yellow; third segment rounded, slightly longer than broad; arista twice as long as third segment of antenna, distinctly thickened on basal fifth, almost bare. Mesonotum and scutellum cinereous or subshiny; humeral callosities and sides of thorax almost entirely yellow; sternopleura brown; four pairs of dorso-central bristles; two rows of acrostichals, with from three to four setae in a row. Legs principally yellow; tarsi brown. Abdomen dark brown, incisures in male narrowly yellow, last incisure broadly yellow; similar in female; ovipositor twice the length of last segment, shiny black. Wings hyaline, veins brown; base of costa, humeral cross-vein, and vein 1 as far as humeral cross-vein, yellow; second, third, and fourth sections of costa as 3:1:1½; vein 4 ending at or only slightly beyond tip of wing; vein 5 ending slightly more than halfway from base of wing to tip; anterior cross-vein nearly twice its length from division of veins 2 and 3; halteres yellow; calypteres and cilia whitish.

This species was compared with European material determined by Hendel.

Phytomyza flavo-scutellata Fall.

1823 *Phytomyza flavo-scutellata* Fall.

Adult.— Medium-sized, color yellowish. Front, face, cheeks, palpi, and proboscis, yellow. Front slightly broader than long, about the same width as either eye, sides converging slightly below; three pairs of fronto-orbital bristles; a row of small setae on orbits adjacent to eye margin; cheeks slightly less than one-half eye height; yellow of cheeks continuing back of eyes and joining yellow of orbits; ocellar triangle dark brown, separated from occiput by a narrow yellow band; back of head brown with a yellow margin; a single row of small setae on hind margin

of head, continuing down hind edge of cheeks. Basal two segments of antennae yellow; second segment with a prominent dorsal seta almost as long as the segment is wide, and a small ventral apical seta; third segment black, rounded, about as long as broad; arista two and one-half times as long as third antennal segment, slender at tip, slightly thickened on basal third, almost bare. Mesonotum cinereous; scutellum yellow in middle, cinereous on sides; humeral callosities and sides of mesonotum and pleurae almost entirely yellow; metapleura somewhat cinereous; four pairs of strong dorso-central bristles; two rows of acrostichals, with about three or four setae in a row; a few small setae outside dorso-centrals; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs yellow. Abdomen subshiny dark brown, the incisures in female narrowly yellow. Wings hyaline, veins brown; base of costa, first vein as far as humeral cross-vein, and humeral cross-vein, partly yellow; second, third, and fourth sections of costa as 4: 1: 2; veins 2 and 3 nearly parallel at tip of wing, vein 2 curving toward anterior margin of wing before terminating; veins 4 and 5 diverging at tip of wing; anterior cross-vein scarcely more than its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia yellow.

Described from European material determined by De Meijere. According to Melander, the species occurs in the western part of the United States. Food plants unknown.

Phytomyza genalis Melander

1913 *Phytomyza genalis* Melander

Adult.— Large, color yellow. Front, face, cheeks, antennae, proboscis, and palpi, entirely yellow. Front slightly broader than either eye, a little longer than broad, sides parallel; four pairs of strong fronto-orbital bristles; two irregular rows of prominent setae between fronto-orbitals and eye margin, becoming bushy at lower extremity of orbits; face elongate, keel not prominent, considerably produced at insertion of antennae; cheeks as broad as eye height, considerably narrowed in front; yellow of cheeks extending back of eyes and joining yellow of orbits; ocellar triangle dark shiny brown, continuous with occiput; a row of strong setae along edge of back of head, two rows of smaller setae adjacent to this row. Antennae entirely yellow; basal segment with two or three dorsal setae; second segment with a prominent dorsal seta and a regular row of setae along outer distal edge of segment; third segment about one and one-half times as long as wide, rounded at tip, almost bare; arista one and one-half times as long as third antennal segment, bare, subshiny. Mesonotum and scutellum cinereous; humeral callosities and sides of thorax chiefly yellow; part of mesopleura, metapleura, sternopleura, and pteropleura, brownish; four pairs of strong dorso-central bristles, preceded by several small setae; two rows of acrostichals, with about three or four setae in a row. Legs chiefly yellow; femora and tibiae entirely yellow; tarsi brown. Abdomen, in female, almost entirely yellow, bases of segments narrowly shiny brown, last segment entirely yellow; in male, segments of abdomen shiny brown, incisures broadly yellow. Wings hyaline, with a brownish tinge; second, third, and fourth sections of costa as 3: 1: 2½; veins 2 and 3 subparallel; veins 3 and 4 distinctly diverging, vein 4 ending considerably beyond tip of wing; vein 5 bending noticeably into costa, ending more than halfway from base to tip of wing; halteres yellow; calypteres and cilia brown.

Described from four specimens in the United States National Museum, from Illinois.

Phytomyza hieracii Hendel

1918 *Phytomyza hieracii* Hendel

Phytomyza hieracii is described by the writer from two specimens in the United States National Museum, one from Germany, determined by

Mart. Hering, the other collected by Aldrich at La Fayette, Indiana. The North American specimen differs from the European one in the following respects: the third antennal segment is entirely black or dark brown; the sides of the thorax, including the humeral callosities and the sides of the mesonotum, are yellow; the scutellum is cinereous in the center; and there is a yellow spot on each side of the mesonotum immediately in front of the scutellum.

Adult.— Large, color principally yellow. Front, face, cheeks, proboscis, and palpi, yellow. Front almost one-half broader than either eye, the sides very slightly converging below, slightly broader than long; orbits and frontal stripe concolorous, yellow; four pairs of fronto-orbital bristles, the lowest pair slightly the smallest; a distinct row of eight or nine small setae on orbits adjacent to eye margin and reaching from the uppermost to below the lowest fronto-orbital bristles; cheeks less than one-half eye height; yellow of cheeks extending back of eyes, and joining yellow of orbits; ocellar triangle shiny brown, separated from occiput by a narrow yellow line; back of head dark brown; a row of distinct setae on edge of back of head extending down hind edge of cheek, two or three rows of small setae on lower half of back of head adjacent to this row. Basal two segments of antennae yellow; third segment brown at tip, yellow at base, slightly longer than broad, covered with a sparse yellow pile; arista two and one-fourth times as long as third segment, almost bare, thickened on basal third. Mesonotum cinereous, dusted with yellow pollen; scutellum yellow, slightly cinereous dusted; sides of thorax cinereous; pleural sutures and base of wings yellow; four pairs of strong dorso-central bristles, preceded by several small setae; a double row of strong acrostichals, about eight setae in a row; a single row of strong setae outside dorso-centrals; an occasional seta in row with dorso-centrals, a strong propleural, a strong mesopleural, and a strong pteropleural bristle. Femora and tibiae chiefly yellow, slightly cinereous; tarsi brown. Abdomen of female entirely yellow, ovipositor shiny black. Wings hyaline, slightly pointed; third, fourth, and fifth sections of costa as 4: 1: 2; vein 2 on its distal half bending slightly toward front margin of wing, but parallel with vein 3 at tip of wing; veins 3 and 4 straight; vein 5 curving distinctly with margin of wing; vein 6 reaching almost to margin of wing; halteres yellow; calypteres white, cilia brown, bushy.

Phytomyza ilicis Curt.

1832 *Chromatomyia ilicis* Curt.
? *Phytomyza obscurella* Weyenb.
1863 *Phytomyza ilicicola* Loew
1913 *Phytomyza obscurella* var. *ilicicola* Melander

Phytomyza ilicis is one of the few species of this genus that mine in thick leaves. The larvae confine themselves entirely to several species of Ilex. The adults, from overwintering puparia, issue exceedingly early in the spring. In the vicinity of Washington, D. C., the writer has found fresh mines on leaves as early as the middle of April. In 1919 Dr. Aldrich sent to the writer leaves of holly containing many larvae which reached the adult stage on the 20th of May.

The mine of *P. ilicis* is not so conspicuous as are those of many of the species of Phytomyza. It is begun as a delicate, script-like tracing on the leaf, but is soon broadened out into an irregular blotch. The frass is inconspicuous. The larva transforms within the mine.

The larvae have been found chiefly on *Ilex opaca*, although Winn and Beaulieu (1915) mention rearing the species from *Ilex verticillata* var. *tenuifolia*, and Weiss (1917) mentions *Ilex glabra*. The writer has reared larvae from *Ilex aquifolium*.

P. ilicis has a wide range in the United States, in addition to its European distribution. It has been recorded as follows: Alaska (Coquillett); Mobile, Alabama (J. J. Davis); Raleigh, North Carolina (Leiby); Washington (Loew, 1863); Washington, Oregon, and California (Melander, 1913); New Jersey (Weiss, 1917). It has been collected also at Boston, Massachusetts, by C. W. Johnson.

Larva.— Length 3.5 to 4 mm. Body pale yellow or whitish in color. Anterior spiracles each with a long and a short branch, bearing about nine stigmatal slits. Mouth hooks quadrangular, with four teeth. Posterior spiracles borne on short peduncles. Stigmatal plate with twenty-two slits arranged in a semicircle.

Adult.— Medium-sized, color blackish. Front, face, and cheeks yellowish, strongly infuscated; palpi black. Front as broad as width of either eye, about as long as wide; orbits opaque; frontal stripe slightly darker in color than orbital stripes; four pairs of fronto-orbital bristles; a single sparse row of small setae on orbits adjacent to eye margin, extending from the uppermost to the lowest fronto-orbital bristles; cheeks about one-half eye height; ocellar triangle cinereous, continuous with occiput; back of head cinereous, a row of small setae on outer margin. Basal segments of antennae dark brown; third segment black, rounded, as long as broad; arista two and one-fourth times as long as third antennal segment, microscopically pubescent, distinctly thickened on basal third. Mesonotum and scutellum cinereous; sides of thorax cinereous subshiny; pleural sutures narrowly yellow; four pairs of dorso-central bristles, the posterior pair the longest; five to six irregular rows of acrostichals, extending about three-fourths the distance to scutellum; two rows of small setae outside dorso-centrals; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs dark brown; femora subcinereous. Abdomen dark brown subshiny, last segment in female with a yellow incisure, ovipositor shiny black; abdomen in male entirely dark brown. Wings hyaline; second, third, and fourth sections of costa as 3½: 1: 2; veins 2 and 3 nearly parallel at tip of wing, vein 3 ending considerably more before tip of wing than vein 4 ends beyond tip of wing; halteres yellow; calypteres and cilia dusky.

Phytomyza major Mall.

1913 *Phytomyza major* Mall.

Adult.— Color yellow. Front, face, cheeks, proboscis, antennae, and palpi, yellow. Front twice as wide as either eye, as long as broad; five pairs of fronto-orbital bristles, the upper two pairs situated near inner margin of orbit, the lower three on middle of orbit; a single row of small setae on orbits next to eye margin; cheeks scarcely as broad as eye height; back of head yellowish or slightly infuscated; a single row of setae on outer edge of back of head, several irregular rows adjacent to this one. Antennae entirely yellow; basal segment with two prominent dorsal setae; second segment with numerous black setae, especially on distal half; third segment of moderate size, scarcely larger than second segment, rounded; arista twice as long as third antennal segment, with short, thick pubescence. Mesonotum yellow, with a slight indication of reddish brown markings; scutellum yellow; four pairs of dorso-central bristles; three irregular rows of acrostichals. Legs chiefly yellow. Abdomen entirely yellow, segments with numerous black setae; ovipositor shiny, dark brown, about as long as last abdominal segment. Wings hyaline; second, third, and fourth sections of costa as 4: 1: 1½;

vein 3 straight; vein 4 straight, ending slightly beyond tip of wing; anterior cross-vein twice its length from division of veins 2 and 3; two strong setae on base of costa preceding humeral cross-vein.

Described from the type in the United States National Museum, from Ungava Bay, Labrador, collected by L. M. Turner.

Phytomyza nervosa Loew

1864 *Phytomyza nervosa* Loew

Adult.— Large. Front, face, cheeks, and proboscis yellow; palpi black, short, much thickened. Front broader than width of either eye, slightly longer than broad; four pairs of strong fronto-orbital bristles; a prominent irregular row of setae on orbits adjacent to eye margin, projecting forward and extending from the third to below the lowest pair of fronto-orbital bristles; an irregular row of setae on outer margin of back of head; front produced slightly at insertion of antennae; cheeks about one-half eye height, distinctly narrower in front than behind; yellow of cheeks extending behind eyes but intercepted at vertex by the black of the back of the head; ocellar triangle subshiny black, separated from occiput by a narrow yellow band. Basal two segments of antennae entirely yellow; third segment large, black, slightly longer than broad; arista bare, two and one-fourth times as long as third antennal joint, thickened on basal fourth. Mesonotum and scutellum cinereous black, dusted with light yellow; humeral callosities and sides of thorax, including base of wings, broadly yellow; sternopleura, mesopleura, and metapleura chiefly cinereous but spotted with yellow; four pairs of strong dorso-central bristles, preceded by a short row of small setae; prominent setae in rows with dorso-centrals; two or three small setae outside dorso-centrals on anterior part of mesonotum; acrostichals absent. Femora chiefly yellow; tibiae and tarsi brown. Abdomen, in male, subshiny dark brown, incisures yellow, last segment almost wholly yellow, genitalia brown; in female, subshiny brown, last segment only with a yellow incisure, ovipositor shiny black and about three times as long as last abdominal segment. Wings with a distinct brownish tinge, veins dark brown; second, third, and fourth sections of costa as $3\frac{1}{2}:1:2$; vein 2 slightly bulging toward costal margin of wing before terminating; vein 3 bending toward hind margin of wing before terminating; vein 4 nearly straight; vein 5 bending gently into margin of wing; vein 6 reaching almost to margin of wing; halteres yellow; calypteres and cilia white.

Described from six specimens in Dr. Aldrich's collection.

Phytomyza nigra Meig.

1830 *Phytomyza nigra* Meig.

Very little is known concerning the occurrence of *Phytomyza nigra* in America. Melander (1913) records the species from Idaho, Washington, and Alaska, indicating a western distribution. Curtis (1832), Goureau (1851), and Karsch (1883) report it as a miner in Europe. It is said to make linear mines on the under side of the leaves of its several host plants. The larvae transform at the end of their mines, in side channels to the main mines. The writer is not familiar with the larvae or the adults of this species. A long list of synonyms is given by Becker and Bezzi (1905) and by Hendel (1918).

The food plants of *P. nigra* have been recorded as follows: *Heracleum sibiricum* (Brischke, 1880); *Aquilegia vulgaris* (Curtis, 1832); *Hera-*

cleum sphondylium (Goureau, 1851); *Arctium* species and *Heloscia-dium nodiflorum* (Karsch, 1883).

Adult.— Small, color blackish. Front, face, and cheeks yellow, but very much darkened; antennae and palpi black. Front slightly broader than width of either eye, sides converging below; three pairs of fronto-orbital bristles; a sparse row of small hairs on orbits adjacent to eye margin; a row of rather prominent setae along outer margin of back of head; cheeks narrow, less than one-half eye height, slightly or not at all narrowed in front; ocellar triangle subshiny black, continuous with the black occiput. Antennae entirely black; third segment rounded, about as long as broad; arista about three times length of third antennal segment, slightly thickened on basal half. Mesonotum, scutellum, and sides of thorax, cinereous subshiny; pleural sutures not at all yellow; four pairs of dorso-central bristles, the anterior two pairs the smallest; two rows of small acrostichals, about three or four setae in a row; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs dark; coxae and femora cinereous; tibiae and tarsi brown; knees slightly pale. Abdomen, in both sexes, subshiny black, the last segment in female with a narrow yellow incisure; ovipositor shiny black, about one and one-half times as long as last abdominal segment. Wings hyaline; second, third, and fourth sections of costa as 4:1:2; veins 2, 3, and 4 comparatively straight, not curving into costa; vein 5 curving gently into costa, terminating about one-half distance from base to tip of wing; vein 6 almost reaching margin of wing; anterior cross-vein about its own length from division of veins 2 and 3; tips of wings rounded; setae on costa preceding humeral cross-vein inconspicuous; halteres yellow; cilia of calypteres pale.

Specimens compared with European material of *P. nigra* Meig. determined by Hendel.

Phytomyza nigripennis Fall.

1823 *Phytomyza nigripennis* Fall.

Adult.— Large, color black. Front, face, cheeks, antennae, and palpi black or dark brown, proboscis yellow. Front considerably broader than either eye, about as broad as long; frontal stripe opaque; orbits and ocellar triangle subshiny; four pairs of fronto-orbital bristles; a row of conspicuous bushy setae on orbits adjacent to eye margin, starting slightly above uppermost and extending to lowest fronto-orbital bristles; back of head subshiny black; a row of prominent setae on outer margin of back of head, extending down on hind margin of cheek; cheeks about one-half eye height, dark brown in color. Antennae entirely black; third segment large, slightly longer than broad, narrower toward distal end than at base; arista twice as long as third antennal segment, almost bare, distinctly thickened on basal fifth. Mesonotum and scutellum cinereous subshiny; sides of thorax entirely subshiny black; pleural sutures not at all yellow; four pairs of strong dorso-central bristles; four to five irregular rows of acrostichals, extending at least three-fourths the distance to scutellum; two rows of small setae outside dorso-centrals. Femora and tibiae cinereous subshiny; tarsi brown; knees pale. Abdomen subshiny black. Wings distinctly clouded, veins dark brown; second, third, and fourth sections of costa as 4:1:2; vein 2 curving forward into costa; veins 4 and 5 diverging considerably at margin of wing; vein 4 curving its entire length, first gently backward, then forward, and finally backward, ending considerably beyond tip of wing; vein 5 ending more than halfway from base to tip of wing, curving slightly into margin of wing; vein 6 nearly reaching margin of wing; anterior cross-vein scarcely one and one-half times its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia pale.

Species compared with material determined by Hendel.

Phytomyza nitida Melander (description on page 129)

1913 *Phytomyza nitida* Melander

Melander described the species *Phytomyza nitida* in 1913. At that time the habits of the larvae were unknown. The writer has reared the species as a leaf-miner on catnip (*Nepeta cataria*), and also on *Ambrosia artemisiifolia*, *Tanacetum vulgare*, and *Thalictrum polygamum*. It is a common species about Ithaca.

The larva produces a linear mine on the upper side of the leaf. The mines are short and comparatively wide, and frequently become blotch-like. At first they are whitish in color, but they become brown when dry. The sides of the mines are marked with rather distinct but irregular lines of frass dots. When full-grown the larvae transform within the mines and the puparia bulge from the lower surface of the leaf.

The species has been recorded from Troy, Bovill, and Moscow, in Idaho, and White Plains, in New York (Melander, 1913), and from Ithaca, Tarrytown, and Florida, New York (the writer).

Phytomyza obscurella Fall.

1823 *Phytomyza obscurella* Fall.

Phytomyza obscurella has been recorded repeatedly in Europe as a leaf-miner. Various authors have recorded it from Greenland, as well as from Denmark and other parts of Europe. Brischke (1880) and Gillanders (1908) state that the larvae transform in their mines. Both Coquillett and Melander record the species from this country, although they mention nothing concerning its habits.

The species feeds on a variety of plants, among them the following: *Actaea spicata*, *Aegopodium podagraria*, *Anthriscus cerefolium*, *A. silvestris*, *Aquilegia vulgaris*, *Pimpinella saxifraga*, *Sedum telephium* (Brischke, 1880); *Lupinus albicaulis* (Coquillett, 1898); *Symphoricarpos racemosus* (Gillanders, 1908); *Sambucus* species (Lundbeck, 1900); *Lonicera xylosteum* (Schiner, 1864).

Adult.— Small to medium-sized, color chiefly black. Front, face, cheeks, and palpi black, proboscis yellow. Front one-half broader than either eye, one and one-half times as broad as long; orbits opaque, concolorous with frontal stripe; three pairs of fronto-orbital bristles; a single row of rather distinct, small setae on orbits adjacent to eye margin; a single row of prominent setae on outer margin of back of head; cheeks narrow, scarcely one-fourth eye height; ocellar triangle subshiny black, continuous with occiput. Antennae entirely black; third segment medium-sized, rounded, about as long as broad; arista slender, about twice as long as third antennal segment. Mesonotum and scutellum subshiny black; four pairs of dorso-central bristles, the anterior pair somewhat the smallest; four to five irregular rows of acrostichals, extending about halfway to scutellum; a few small setae outside dorso-centrals; pleural sutures narrowly yellow. Legs brown. Abdomen, in female, subshiny black, last incisure broadly yellow, ovipositor shiny black; in male, last two incisures narrowly yellow. Wings hyaline, base distinctly pale yellow including costa halfway to humeral cross-vein and vein 1 to humeral cross-vein; second, third, and fourth sections of costa as $3\frac{1}{2}:1:1\frac{1}{2}$; vein 2 bending

toward vein 3, then away from vein 3, finally diverging slightly from vein 3 at margin of wing; vein 4 nearly straight; anterior cross-vein about twice its length from division of veins 2 and 3; halteres pale yellow; calypteres pale, cilia dusky brown.

Species compared with European material determined by Hendel.

Phytomyza obscurella var. *nigritella* (Zett.) Melander

1848 *Phytomyza nigritella* Zett.
1913 *Phytomyza obscurella* var. *nigritella* (Zett.) Melander

The habits of *Phytomyza obscurella* var. *nigritella* have not heretofore been recorded. Melander (1913) records the variety from Europe, Greenland, Idaho, and Washington. It has been collected also at Estevan, in Saskatchewan, Canada. The writer has reared it from the leaves of peach, wild black cherry, and bush honeysuckle, at Arendtsville, Pennsylvania (where it is exceedingly abundant), and at Ithaca, New York.

The mine is very characteristic. It is linear in form, is rather long but seldom very tortuous, and is whitish or greenish in color. The frass is arranged in a very conspicuous row of spots along the center. The larva frequently makes several short radiating mines before starting the one that it finally completes. The mine is slightly broader at its extremity than elsewhere, and it is at this point that the full-grown larva transforms. The puparium is plainly visible within the mine. The transparent upper epidermis of the leaf, where the puparium lies against it, appears as a small round window with the anterior spiracles of the puparium projecting through.

It is a curious fact that the mines produced by this species resemble very closely those produced by a species of Lepidoptera, the lesser bud moth (*Recurvaria nanella* Hübner). Perhaps the similarity of the mines produced by these two species has caused the dipterous miner to be overlooked.

There are at least two generations during the summer. About the first of June the flies that have issued from the overwintering puparia begin laying eggs. The eggs are laid on the leaves of the host plants. From the middle to the end of June the larvae of the first generation may be seen maturing in their mines. About the 30th of June the adults of the first generation begin to issue. This continues until the 5th or the 10th of July, when these adults begin laying eggs for a second generation. Many parasites issue during the summer. Most of these issue earlier than the flies themselves, thus having an opportunity to mate and be prepared for the second generation of leaf-mining larvae.

Larva.— Length 4 mm. Body whitish in color, slightly thicker anteriorly, truncate at posterior end. Anterior spiracles projecting conspicuously, biforked, with about twenty-six stigmatal slits at end of fork. Mouth hooks quadrangular, with four teeth. Posterior spiracles projecting, bearing eight stigmatal slits.

Adult.— Small, color black. Front, face, and cheeks principally black, proboscis yellow; frontal stripe and orbits opaque black. Front as wide as either eye, sides parallel; four pairs of fronto-orbital bristles; a row of small setae on

orbits adjacent to eye margin; cheeks narrow, not more than one-fourth eye height; palpi black; occiput black subshiny. Antennae entirely black; third segment of medium size, rounded, as long as wide; arista microscopically pubescent, moderately thickened at base, scarcely more than twice as long as third antennal segment. Mesonotum and scutellum cinereous black; pleural sutures narrowly yellow; four pairs of dorso-central bristles, the anterior two pairs the smallest; four to five rows of acrostichals, extending at least three-fourths the distance to scutellum; a few similar setae outside dorso-centrals. Legs black. Abdomen, in both sexes, dark brown to black, subshiny; ovipositor shiny black, one and one-half times as long as last abdominal segment. Wings hyaline; second, third, and fourth sections of costa as 4: 1. 2½; vein 3 ending considerably before tip of wing; veins 3 and 4 diverging considerably; vein 6 not reaching wing margin; anterior cross-vein not more than one and one-half times its length from division of veins 2 and 3; halteres yellow; cilia of calypteres brown.

Phytomyza orbitalis Melander

1916 *Phytomyza orbitalis* Melander

Adult.— Size medium to small, color principally black or brown. Front, face, cheeks, and antennae black, proboscis yellow. Front slightly broader than width of either eye; center of front opaque, brownish below, pale above; orbits darkened on upper outer angles, and with a yellow stripe bearing four fronto-orbital bristles; no small setae between fronto-orbitals and eye margin; cheeks very narrow, about one-fifth eye height; ocellar triangle shiny black, continuous with black of back of head; oral vibrissae weak. Antennae black or dark brown; third segment only slightly longer than broad; arista slender, about twice as long as third segment, only microscopically pubescent. Mesonotum and scutellum shiny black; sides of thorax subshiny black; pleural sutures distinctly yellow; five pairs of dorso-central bristles, the anterior pair weak and scarcely differentiated from acrostichals; acrostichals numerous, arranged in four rows extending three-fourths the distance to scutellum; a pair of slender setae between posterior pair of dorso-centrals. Legs dark brown; tarsi paler. Abdomen shiny brown, in male the incisures narrowly yellow. Wings hyaline, veins brown; second, third, and fourth sections of costa as 3½:1:1½; veins 2 and 3 curving slightly, subparallel at tip, vein 3 terminating slightly before wing tip; vein 4 nearly straight, terminating slightly beyond wing tip; vein 5 curving gently into wing margin; anterior cross-vein two and one-half times its length from the division of veins 2 and 3; halteres pale yellow; calypteres pale, edge and cilia slightly dusky.

Described from a paratype from Kamiac Butte, Washington, loaned by Dr. A. L. Melander.

Phytomyza palliata Coq.[3]

1902 *Phytomyza palliata* Coq.

Coquillett (1902) described the species *Phytomyza palliata* from a single specimen reared from Portulaca in New Mexico. No record of rearing or collecting this miner has been made, so far as the writer knows.

Phytomyza plantaginis R-D.

1851 *Phytomyza plantaginis* R-D.
1851 *Phytomyza robinaldi* Gour.

Phytomyza plantaginis runs close to *P. chrysanthemi*, but is readily distinguished from that species by the following characters: front

[3] placed in the genus *Antineura*.

broader; third antennal segment longer, quadrate, inner surface not conspicuously pilose; arista nearly two and one-half times as long as third antennal segment, slightly thickened at base and tapering gradually at tip; a few scattered acrostichal bristles sometimes present.

The writer has reared *P. plantaginis* from *Plantago lanceolata* and *P. major*. It is not a very abundant species, although the mines have frequently been seen on plantain at various localities in Pennsylvania, New York, and New Jersey. The mine is linear in form, is long and in some cases tortuous, and usually occurs on the upper surface of the leaf. It is whitish in color, with little or no frass evident. The puparium is formed at the end of the mine, causing the leaf to bulge considerably, and the anterior spiracles protrude through the upper epidermis.

The writer has collected adults as early as April 30, and the larvae have been found abundantly throughout May, June, July, and August.

This species mines in two genera of plants. The writer has reared it from *Plantago lanceolata* and *P. major*. Goureau (1851) records it from *Plantago lanceolata*, Brischke from *Populus tremula*, and Karsch (1883) from *Populus nigra* and *P. dilatata*. The writer has found blotch mines common on poplar, but has never reared the adults from the larvae that produced them. Judging from the difference in the form of the mines, they were no doubt made by another species.

P. plantaginis appears to be common throughout the United States. It has been taken at Salt Lake City, Utah, and at Glen Echo, Maryland. The writer has reared and collected the species at Ithaca, New York, and at Arendtsville, Pennsylvania. Dr. Aldrich reports that he found it very abundant at Glen Echo, Maryland, where he swept 78 specimens from grasses and weeds.

Larva.— Length 5 mm. Body subcylindrical, slightly thicker at anterior end. Anterior spiracles fan-shaped, with five stigmatal slits. Mouth hooks quadrangular, with two teeth, one large and curved, the other small and straight. Posterior spiracles on short prominences, with seven stigmatal slits arranged in a semicircle.

Adult.— Medium-sized, color chiefly yellow. Front, face, cheeks, proboscis, and palpi, yellow. Front slightly broader than either eye, a little longer than broad, sides parallel; cheeks about three-fourths eye height, slightly narrower in front than behind; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle black, continuous with occiput; orbits darkened on upper outer angles; three pairs of fronto-orbital bristles; a row of six small setae on orbits adjacent to eye margin, projecting forward and extending from slightly below the uppermost to slightly below the lowest fronto-orbital bristles; occiput cinereous; a row of small setae on outer edge of back of head. Basal two segments of antennae yellow; third segment black, rounded, slightly longer than wide, sparsely covered with a yellowish pile; arista one and one-half times as long as third antennal segment, almost bare, thickened on basal third. Mesonotum, scutellum, and metanotum cinereous; sides of thorax cinereous; pleural sutures narrowly yellow; four pairs of strong dorso-central bristles, preceded by a few small bristles; acrostichals absent, only an occasional seta between dorso-centrals; propleura, mesopleura, and sternopleura each with a strong bristle. Legs black cinereous; knees broadly yellow. Abdomen,

in both sexes, subshiny black, the last incisure yellow; ovipositor slightly longer than last segment. Wings hyaline; second, third, and fourth sections of costa as 3: 1: 3; veins 2, 3, and 4 nearly straight; vein 5 bending gently into costa; anterior cross-vein scarcely more than its own length from division of veins 2 and 3; halteres yellow; calypteres and cilia pale.

Species compared with European material determined by Hendel, and with other material determined by Mart. Hering.

Phytomyza praecox Meig.

1830 *Phytomyza praecox* Meig.
1864 *Phytomyza zetterstedti* Schin.

Adult.— Medium-sized, color chiefly yellow. Front, face, cheeks, and proboscis yellow, palpi black. Front about as broad as either eye, as long as broad, sides converging slightly below; three pairs of strong fronto-orbital bristles; a row of small setae on orbits adjacent to eye margin, extending from uppermost to lowest fronto-orbital bristles; cheeks hardly one-half eye height; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; back of head with a row of small setae on outer edge, continuing down hind margin of cheeks. Basal segment of antennae yellow; second and third segments black; third segment large, somewhat quadrate, covered with a brownish pile; arista twice length of third antennal segment, microscopically pubescent. Mesonotum cinereous; scutellum yellow in middle, cinereous on sides; humeral callosities and sides of thorax broadly yellow; four pairs of strong dorso-central bristles; two rows of acrostichals, with about five or six setae in a row; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs chiefly pale; femora and tibiae yellow; tarsi brown. Abdomen, in female, subshiny brown; incisures only narrowly yellow; ovipositor shiny black, about same length as last segment. Wings hyaline; second, third, and fourth sections of costa as 4: 1: 2; veins 2 and 3 subparallel, vein 2 bulging toward anterior margin of wing in the latter part of its course but terminating parallel with vein 3; veins 4 and 5 curving gently into margin of wing; halteres yellow; calypteres pale, cilia brown.

Described from two specimens in Dr. Aldrich's collection, from La Fayette, Indiana. Hendel (1918) places *maculipes* Zett. and *zetterstedti* Schin. in synonymy.

Phytomyza affinalis n. sp.[4]

Adult.— Large, resembling *P. affinis*. Front, face, cheeks, and proboscis, yellow. Front one-half wider than either eye, slightly broader than long, sides parallel; five pairs of strong fronto-orbital bristles (one specimen shows six pairs); an irregular row of small, prominent setae on orbits adjacent to eye margin, projecting forward and reaching from slightly below uppermost pair of fronto-orbital bristles to slightly below lowest pair; front produced somewhat at insertion of antennae; antennal grooves darkened, shiny black; cheeks about one-half eye height; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle and black of back of head continuous; edge of back of head with a single row of prominent setae, the uppermost one considerably enlarged. Antennae entirely black; third segment rounded, slightly longer than wide, covered with a dense brownish pile; arista one and one-half times as long as third antennal segment, nearly bare. Mesonotum and scutellum cinereous, dusted with yellow; four pairs of strong dorso-central bristles; two rows of acrostichals, eight to nine setae in a row; no small setae outside dorso-centrals except a few near anterior margin of mesonotum; a strong propleural, a strong mesopleural, and a strong sternopleural bristle; sides of thorax cinereous except

[4] All the types of Phytomyza described in this paper have been deposited in the United States National Museum.

pleural sutures, which are narrowly yellow. Legs dark brown; femora subcinereous; knees broadly yellow. Abdomen, in both sexes, subshiny black, incisures narrowly yellow; ovipositor shiny black, one and one-half times length of last abdominal segment. Wings hyaline; second, third, and fourth sections of costa as 3:1:2 or 2¼; veins 3 and 4 straight; vein 5 curving gently into margin of wing; vein 6 almost reaching wing margin; two strong setae on costa at base of wing, of equal length; halteres yellow; calypteres pale, cilia brown.

Described from one male and seven females in the United States National Museum, from Estevan, Saskatchewan, Canada, collected by Dr. J. M. Aldrich.

Phytomyza flavinervis n. sp.

Adult.— Large. Front, face, cheeks, antennae, proboscis, and palpi, yellow. Front hardly as wide as either eye, nearly one-half longer than broad, sides parallel; four pairs of strong fronto-orbital bristles; a double row of small setae on orbits adjacent to eye margin, extending from the uppermost to slightly below the lowest fronto-orbital bristles; cheeks slightly less than eye height; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle cinereous, continuous with occiput; occiput and back of head cinereous; three sparse rows of small setae on outer margin of back of head, continuing down hind margin of cheek. Antennae entirely yellow; second segment with a black dorsal seta; third segment large, rounded, bare; arista almost bare, about twice length of third antennal segment, thickened on basal third. Mesonotum, scutellum, and sides of thorax, with the exception of pleural sutures, cinereous; pleural sutures and base of wing yellow; four pairs of strong dorso-central bristles, preceded by a double row of small setae; several irregular rows of acrostichals; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Femora cinereous; tibiae and tarsi brown; knees broadly yellow. Abdomen, in female, subshiny brown, incisures distinctly and broadly yellow, last incisure almost half as broad as segment; ovipositor shiny black, twice length of last segment. Wings hyaline, veins all pale yellow; second, third, and fourth sections of costa as 2:1:1½; vein 3 almost straight, curving gently anteriorly at margin of wing; vein 4 curving rather prominently into margin of wing; costa with two strong setae before humeral cross-vein; halteres yellow; calypteres and cilia white.

Described from two specimens in the United States National Museum, from Belfarge, Texas. Collector unknown.

Phytomyza lactuca n. sp.

Phytomyza lactuca has been described from four specimens reared from *Lactuca scariola* var. *integrata* at Arendtsville, Pennsylvania. It runs close to *P. tenella* Meig., but the third antennal segment is covered with long, dense, whitish pubescence, the antennae are entirely black, and the cilia of the calypteres are brown.

Adult.— Front, face, cheeks, knees, halteres, and base of wings, yellow; frontal stripe and orbits concolorous, pale yellow; palpi black. Front about as broad as long; three pairs of slender fronto-orbital bristles; a double row of small setae between orbitals and eye margin; a single small seta on each side of head immediately below fronto-orbitals; orbits slightly darkened on upper outer angle; cheeks pale yellow, the yellow extending back of eyes but intercepted at top of eyes by the black of the back of the head; ocellar triangle black, continuous with black of back of head; back of head cinereous black, a single row of fine setae along outer edge reaching almost to posterior vertical bristle; one weak oral vibrissa, several smaller ones. Antennae entirely black, not cinereous; second segment with a dorsal seta; third segment as broad as long, distinctly

broader at tip than at base, its outer surface covered with dense, long pubescence nearly half as long as the segment itself; arista slender, not distinctly thickened at base, absolutely bare. Mesonotum cinereous; pleural sutures narrowly yellow; four pairs of strong dorso-central bristles, preceded by one or two small setae; a double row of acrostichals, three to four setae in a row, starting just behind anterior pair of dorso-centrals and extending to slightly behind second pair of dorso-centrals; a few small setae outside dorso-centrals. Legs cinereous; knees yellow; base of anterior femur frequently yellow. Abdomen subshiny brown; incisures pale yellow in female, not yellow in male. Wings hyaline, rounded at tip; veins dark brown, but base of costa to and slightly beyond humeral cross-vein, and vein 1 to and slightly beyond humeral cross-vein, yellow; second, third, and fourth sections of costa as 3 : 1 : 1½; veins 2 and 3 subparallel at tip, vein 2 curving gently toward anterior margin of wing at middle, vein 3 ending slightly before wing tip; vein 4 straight, ending only slightly beyond wing tip; vein 5 curving very gently into costa; costa thickened to or only slightly beyond tip of vein 3; vein 6 comparatively strong, extending two-thirds the distance to margin of wing; anterior cross-vein one and one-half times its length from division of veins 2 and 3; halteres yellow; calypteres pale yellow, cilia pale brown.

Phytomyza melanella n. sp.

Adult.— Small, 3 mm. long. Front, face, and cheeks largely yellow, infuscated; palpi black. Front about same width as either eye, about as broad as long, sides nearly parallel; four pairs of fronto-orbital bristles, the lowest pair often the weakest; a row of small setae on orbits adjacent to eye margin, projecting forward and extending from the uppermost to slightly below the lowest fronto-orbital bristles; cheeks about two-thirds eye height, considerably narrowed in front; ocellar triangle, upper angles of orbits, and back of head, cinereous; a row of minute setae on edge of back of head, these becoming longer as they continue down hind margin of cheek. Antennae entirely black; third segment of medium size, rounded, as long as broad; arista almost bare, one and one-half times length of third antennal segment, thickened on basal third. Mesonotum and scutellum subshiny cinereous; sides of thorax cinereous; pleural sutures very narrowly yellow; four pairs of strong dorso-central bristles; two rows of acrostichals, with three to four setae in a row; a strong mesopleural and a strong sternopleural bristle. Legs entirely brown; knees slightly paler. Abdomen dark brown subshiny, in male the incisures yellow. Wings hyaline, veins pale; second, third, and fourth sections of costa as 3:1:3; veins 2 and 3 curving distinctly toward anterior margin of wing before entering costa; vein 4 straight; vein 5 curving gently into margin of wing; halteres yellow; calypteres gray, cilia brown.

Described from five specimens in the United States National Museum, from Los Angeles, California, and Argus Mountains, Kentucky, collected by D. W. Coquillett.

Phytomyza minuta n. sp.

Adult.— Small, 2 to 2½ mm. long. Front, face, cheeks, proboscis, antennae, and palpi, yellow. Front slightly narrower than either eye, twice as long as broad; four pairs of fronto-orbital bristles, of equal length; a sparse row of minute setae, about four or five, on orbit adjacent to eye margin; cheeks narrow, hardly one-half eye height; yellow of cheeks continuing back of eyes and joining yellow of orbits; ocellar triangle dark brown, separated from occiput by a narrow yellow line; upper half of back of head dark brown, the outer edge with a single row of small setae extending down hind edge of cheek. Antennae entirely yellow; third segment small, rounded, as long as broad, bare; arista dark brown, about twice as long as third antennal segment, bare, distinctly thickened on basal third. Mesonotum cinereous; scutellum yellow in center, cinereous on sides; humeral

callosities and sides of thorax chiefly yellow; meso-, meta-, and sternopleura with cinereous patches; four pairs of strong dorso-central bristles, the anterior pair slightly the weakest; a double row of acrostichals, with three to five setae in a row; a strong propleural, a strong mesopleural and a strong sternopleural bristle. Legs largely yellow; coxae, femora, and tibiae yellow; tarsi brownish. Abdomen, in female, subshiny dark brown, incisures distinctly and broadly yellow, last segment entirely yellow with two brown spots, one on each side of base of segment, ovipositor shiny black, scarcely longer than last segment; in male, segments subshiny dark brown, incisures broadly yellow, last two segments with a median yellow line forming two brown spots at base of each segment. Wings hyaline; second, third, and fourth sections of costa as 3:1:1; veins 2, 3, and 4 subparallel; anterior cross-vein at least three times its length from division of veins 2 and 3; halteres pale yellow; calypteres and cilia white.

Described from two males and three females in the United States National Museum from Marfa (Texas), Bismarck and Fargo (North Dakota), and Las Cruces (New Mexico), collected by Dr. J. M. Aldrich.

Phytomyza nigrinervis n. sp.

Adult.— Large, 3 to 3½ mm. long. Front, face, cheeks, antennae, and palpi, black. Front one and one-half times as broad as width of either eye, one-half longer than broad; four pairs of fronto-orbital bristles, the lowest pair somewhat the smallest; a row of small, forward-projecting setae on orbit adjacent to eye margin, extending from uppermost to lowest fronto-orbital bristles; cheeks slightly more than one-half eye height; a single row of prominent setae on edge of back of head continuing down hind edge of cheeks. Antennae entirely black; third segment somewhat quadrate, about as long as broad, covered with a dense microscopic pile; arista two and one-fourth times as long as third antennal segment, microscopically pubescent, and thickened on basal third. Mesonotum and scutellum subshiny black; sides of thorax entirely black or brown, including pleural sutures and base of wing; four pairs of strong dorso-central bristles; about four sparse irregular rows of acrostichals reaching three-fourths the distance to scutellum; two irregular rows of small setae outside dorso-centrals; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs dark brown to black. Abdomen, in both sexes, subshiny black. Wings slightly milky, slightly tinged along veins; veins 1, 2, 3, 5, and 6, dark brown to black; second, third, and fourth sections of costa as 3:3½:2; veins 2 and 3 nearly straight, diverging but slightly, vein 2 curving slightly toward front margin of wing as it enters costa; vein 4 straight, diverging considerably from vein 3 and ending slightly beyond tip of wing; vein 5 equally as strong as veins 2 and 3, ending more than halfway from base to tip of wing; halteres yellow; calypteres and cilia dark brown.

Described from ten specimens in the United States National Museum, from Tennessee Pass, Colorado, collected by Dr. J. M. Aldrich.

Phytomyza plumiseta n. sp.

The species *Phytomyza plumiseta* runs close to *P. albiceps*. It is more hairy than *albiceps*, its arista being distinctly pubescent or almost plumose, and it has numerous long acrostichals extending almost to the scutellum. The color characters in *albiceps* and *plumiseta* cannot be relied upon. The majority of the specimens of *plumiseta* have the pleurae and the humeri broadly yellow, but some of the specimens are almost black.

The writer has reared the species from the leaves of *Thalictrum polygamum* and *Aquilegia canadensis*. The larvae apparently do not begin

their activity until the middle of summer. In the writer's work, the first larvae were noticed on July 5. During the latter part of July and through August and a part of September, the larvae and the mines were abundant on meadow rue (*Thalictrum polygamum*), and they increased in numbers as the season progressed. This was very evident as the mines were removed every few days from some plants near the laboratory.

The larvae make blotch mines on the leaves of *Thalictrum polygamum* which differ very much from the blotch mines produced by another species on the same host. A single larva occupies a mine and it is uncommon to find more than one mine on a leaflet. The larva removes the parenchyma in the center of the mine. As the larva continues to feed, the parenchyma is entirely removed about this island, making a clear space about the central part of the mine. The frass is accumulated in the center of the mine, resulting in a darkened central area. The remainder of the mine is pale green or whitish in color. The larva when full-grown transforms within the leaf, the puparium usually resting in the center of the mine.

Another species, *Agromyza curvipalpis*, may occur on the same host plant (*Thalictrum polygamum*). The mines of this species, however, are quite different from those produced by *Phytomyza plumiseta*. They do not have the central dark area, and are inclined to be linear rather than blotch. Furthermore, the larvae of *Agromyza curvipalpis* abandon the leaves to transform.

The species has been found common at Arendtsville, Pennsylvania, and has been reared at Florida, New York. Mines have been found abundant on meadow rue at Ithaca, New York, but the adults have never been reared from this locality, so far as the writer knows.

Adult.— Medium-sized. Front, face, cheeks, and proboscis yellow, palpi black. Front hardly as wide as either eye, sides converging below; orbits about half as wide as frontal stripe; four pairs of strong fronto-orbital bristles; a single row of small setae on orbits adjacent to eye margin, extending from uppermost to lowest fronto-orbital bristles; antennal grooves slightly darkened; cheeks scarcely one-fourth eye height, narrower in front than behind; yellow of cheeks continuing back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle continuous with occiput, upper outer angles of orbits darkened; edge of back margin of head with a conspicuous row of small setae continuing down hind margin of cheek. Basal segments of antennae brownish; third segment black, slightly longer than broad, rounded; arista microscopically but distinctly plumose, about two and one-fourth times as long as third antennal segment, distinctly thickened on basal third. Mesonotum and scutellum cinereous; humeral callosities and sides of thorax broadly yellow; a yellow spot on either side of mesonotum immediately in front of scutellum; four pairs of strong dorso-central bristles; acrostichals numerous, arranged in six or seven irregular rows extending about three-fourths the distance to scutellum; mesopleura and sternopleura each with a strong seta. Coxae and femora dark brown; tibiae and tarsi pale brown; knees pale yellow. Abdomen subshiny brown; in male, incisures broadly yellow, almost half as wide as segment, setae black, genitalia dark brown; in female, incisures narrowly yellow, last incisure broad, ovipositor dark brown shiny. Wings hyaline, veins dark brown, but base of costa, and vein 1 to humeral cross-vein,

yellow; second, third, and fourth sections of costa as 3:1:1; veins 3 and 4 straight, subparallel on their distal half; vein 5 strong, curving gently into margin of wing; vein 6 nearly reaching margin of wing; anterior cross-vein twice its length from division of veins 2 and 3; halteres yellow; calypteres pale, cilia brown, bushy.

Described from twenty specimens reared from *Thalictrum polygamum* at Arendtsville, Pennsylvania.

Phytomyza subtenella n. sp.

Adult.— Medium-sized, 2½ mm. long. Front, face, cheeks, proboscis, palpi, and basal segments of antennae, yellow. Front one-half broader than either eye, longer than broad, sides parallel; four pairs of slender fronto-orbital bristles, the lower two pairs approximated and situated on outer edge of orbits, the upper two pairs located on inner margin of orbits; a row of small, prominent setae on orbits adjacent to eye margin, extending from uppermost orbital bristles to line of antennae; cheeks two-thirds eye height, considerably narrowed in front; yellow of cheeks extending back of eyes but intercepted at vertex by the black of the back of the head; ocellar triangle dark brown, continuous with occiput; a double row of small setae on outer edge of back of head. Basal segments of antennae yellow; third segment black, quadrate, slightly longer than broad, covered with a dense yellowish pile; arista about twice as long as third antennal segment, thickened on basal third. Mesonotum, scutellum, and sides of thorax cinereous; pleural sutures and base of wings yellow; four pairs of strong dorso-central bristles; two rows of rather strong acrostichals; a strong propleural, a strong mesopleural, and a strong sternopleural bristle. Legs chiefly dark brown; front coxae yellow; femora cinereous; knees broadly yellow. Abdomen, in female, dark subshiny brown, incisures broadly yellow; last incisure one-half width of segment; ovipositor shiny black, elongate, about three-fourths length of abdomen. Wings hyaline; second, third, and fourth sections of costa as 4: 1: 2; veins 2 and 3 subparallel, vein 3 almost straight, curving but slightly as it enters margin of wing; vein 4 straight; vein 5 curving slightly into wing margin; two prominent setae on costa at base of wing, the inner one the longer; halteres yellow; calypteres and cilia pale whitish.

Described from two females in the United States National Museum, from Mount Rainier (Washington) and Polk County (Wisconsin), collected by Baker.

Phytomyza trivittata n. sp.

Adult.— Medium-sized, 2 mm. long. Front, face, cheeks, palpi, and basal segments of antennae, yellow. Front slightly broader than width of either eye, one-half longer than broad; four pairs of slender fronto-orbital bristles, the lowest pair the smallest; a row of minute setae on orbit adjacent to eye margin; cheeks as broad as eye height, distinctly narrowed in front; face twice as long as wide; antennal grooves not darkened, the yellow of cheeks continuing back of eyes and joining yellow of orbits; ocellar triangle brown, broadly separated from occiput by a yellow band; occiput and back of head dark brown, with a distinct yellow edge; a row of minute setae on edge of back of head, continuing down hind edge of cheek. Basal two segments of antennae yellow; third segment black, rounded at apex, one-fourth longer than broad, microscopically pilose; arista slender, almost bare, thickened on basal third. Mesonotum largely reddish cinereous; a large yellow quadrate spot immediately in front of scutellum, from this spot two yellow bands extending halfway to anterior margin of mesonotum, dividing the darker part into three vittae; scutellum and sides of thorax yellow; sternopleura reddish cinereous; four pairs of slender dorso-central bristles, the three anterior pairs of equal length, the posterior pair longer; acrostichals absent; no small setae outside dorso-centrals; a slender propleural, a slender mesopleural, and a slender sternopleural bristle. Legs entirely yellow. Abdomen, in male,

subshiny brown, incisures only indistinctly yellow. Wings hyaline; second, third, and fourth sections of costa as 2½:1:3; vein 3 curving slightly toward anterior margin of wing before entering costa; vein 4 entirely straight; vein 5 curving gently into margin of wing; halteres yellow; calypteres and cilia white.

Described from one male in the United States National Museum, from Wells, Nevada, collected by J. M. Aldrich.

Family **Drosophilidae**

The flies belonging to the family Drosophilidae are closely related in structure to the Agromyzidae and the Ephydridae, but in habits they are, for the most part, quite different. A table of the structural characteristics of these three families has already been given (page 35).

Genus **Scaptomyza** Hardy

The genus Scaptomyza was proposed by Hardy (1849) to include the leaf-mining Drosophilidae. Coquillett (1900) pointed out well-defined systematic characters separating Scaptomyza from Drosophila. He says: "In Scaptomyza these hairs [on the mesonotum] are sparse and are arranged in two or four nearly regular rows, while in Drosophila as restricted they are numerous and not arranged in two or four rows." Sturtevant (1916) agrees that the genus Scaptomyza is easily recognized in our American species by the characters pointed out by Coquillett. He states, further: "The larvae are not exclusively leaf miners, as I have bred *S. adusta* Lw. and *S. graminum* Fall. through several generations on tomato fruits and also on potato tubers." The writer has reared *S. adusta* repeatedly from various Cruciferae and from garden peas, so that there is no doubt as to its mining habits.

Scaptomyza adusta Loew

1862 ***Drosophila adusta*** Loew
1892 ***Scaptomyza flaveola*** Garman (*nec* Meig.)

Of the various leaf-mining Drosophilidae, *Scaptomyza adusta* is the commonest form about Ithaca, New York. The writer has reared it chiefly from the Cruciferae, although a single species of Leguminosae and a single species of Amaranthaceae are host plants also. Chittenden (1902) records *Scaptomyza adusta* first as a leaf-miner on *Brassica campestris*. The writer adds the following host plants: *Amaranthus retroflexus*, *Barbarea vulgaris*, *Brassica oleracea*, *B. rapa*, *Pisum sativum*, *Radicula armoracia*, and *Raphanus sativus*.

The species *Scaptomyza flaveola* mentioned by Garman is referable to *S. adusta* Loew. The writer examined some of Garman's specimens and found them identical with specimens of *S. adusta*.

The adults occur abundantly during the summer and are frequently taken in sweeping fields or along roadsides. They continue their activity throughout the warm season, and several generations are produced during the course of the summer. The larvae may be found mining leaves at any time during the summer.

The larvae are gregarious. Remarkably large numbers have been found within a single mine. The writer has counted 28 larvae within a single leaf of the garden pea. The larvae produce blotch mines on the leaves of various host plants. The mines occur chiefly on the upper side of the leaf and close to the midrib. The midrib is mined, as well as the leaf, and the blotch extends on both sides, often forming finger-like processes. The mine is further characterized by a peculiar spotting due to the frass arranged in small pellets about its outer edge. Another species of miner, *Agromyza pusilla*, frequently mines the same host plants, but its mines are readily distinguished because they are linear, or, if blotched, show signs of scroll-like linear tracings on the leaf. The larvae of *Scaptomyza adusta* usually transform within the mine, but some work their way down the petiole of the leaf, where they transform.

Although the larvae are abundant, the mortality is high due to the activities of parasites. Several species of parasites have been reared, including *Opius quebecensis* Prov., *Chrysocharis* sp., and *Dacnusa scaptomyzae* Gahan. The last-named has been found in by far the greatest abundance. The amount of parasitism, and the time of emergence of the parasites with reference to the emergence of the flies, are shown in table 9:

TABLE 9. EMERGENCE OF ADULTS AND LARVAL PARASITES OF SCAPTOMYZA ADUSTA

Host plant of miner	Number of puparia (*S. adusta*)	Date of formation of puparium	Date of emergence of flies and parasites	Number of adults issuing (*S. adusta*)	Number of larval parasites
Barbarea vulgaris	21	July 3	July 12	7	2
Barbarea vulgaris	1	Aug. 7	Aug. 17	1	0
Barbarea vulgaris	13	Aug. 22–27	Sept. 7–9	0	14
Brassica campestris	10	July 2	July 23 to Aug. 1	1	8
Brassica campestris	2	Aug. 12–13	Aug. 25 to Sept. 3	0	3
Brassica oleracea	6	Aug. 10	Aug. 19–25	2	1
Pisum sativum	42	July 17–18	July 21–26	26	0
Raphanus sativus	3	June 28	July 12	0	1
Raphanus sativus	64	Sept. 13–14	Sept. 22 to Oct. 7	0	18
Total.....	162	.....	.....	37	47

So far as is known, this species is limited to the eastern United States. It occurs chiefly along the Atlantic Coast and barely reaches the Mississippi Valley. The following distribution records, many of which have not been published, are cited here: Eastport (Maine), Washington (D. C.), Algonquin (Illinois), Augusta (Georgia), and Virginia, reported by Chittenden (1902); Lexington (Kentucky), reported by Garman (1892); Danvers (Massachusetts), Norwalk and New Haven (Connecticut), Cape May and Newark (New Jersey), Philadelphia (Pennsylvania), Hartford County (North Carolina), and St. Augustine, Daytona, and Biscayne Bay (Florida), reported by Johnson; Raleigh (North Carolina), reported by Sherman; Ithaca, Tarrytown, and Florida (New York), and Arendtsville (Pennsylvania), reported by the writer.

Larva.— Length 5 to 5.5 mm. Body slender subcylindrical, noticeably tapering toward anterior end. Anterior spiracles fan-shaped, with five stigmatal slits. Posterior end tuberculate; two prominent ventro-lateral tubercles on each side of last segment; spiracles located on a pronounced posterior projection of last segment.

Scaptomyza flaveola Meig.

1823 *Drosophila flava* Fall.
1830 *Drosophila flaveola* Meig.
1847 *Drosophila pallida* Zett.
1849 *Scaptomyza apicalis* Hardy

Scaptomyza flaveola is a European leaf-mining form which has been repeatedly recorded from the United States. It is known in economic literature as the *imported cabbage leaf-miner*. Coquillett (1895 b) was the first to record its occurrence in this country. Sturtevant (1916), however, believes that *S. flaveola* does not occur in North America, and that the many records of this species are referable to *S. adusta* Loew, *S. graminum* Fall., or *S. terminalis* Loew. In view of this situation, it is impossible to determine what species the various authorities had in mind in making their records. The writer examined specimens of larvae, pupae, and adults which were used in the preparation of Bulletin 40 of the Kentucky Agricultural Experiment Station (Garman, 1892), and found them to be *S. adusta* Loew, not *S. graminum* Fall.

According to European writers, *S. flaveola* has a somewhat varied list of host plants, but it seems to mine principally in the Cruciferae. Among the various hosts recorded in Europe are the following: *Tropaeolum canariense* (Coquillett, 1895 b); *Anthyllis vulneraria, Brassica campestris, Cochlearia officinalis, Pisum sativum* (Francis Walker, 1853, quoting from Hardy). The following American records are doubtfully added: *Brassica oleracea, B. oleracea* var. *botrytis* (Britton, 1896); *Papaver medicinale, Solanum carolinense, Stenophragma thalianum* (Chittenden, 1902); *Raphanus sativus* (Coquillett, 1895 b).

As already mentioned, the species is of doubtful occurrence in the United States. The following records, probably all referring to *S. adusta*

Loew, are found in American literature: Connecticut (Britton, 1896); Tennallytown, D. C. (Chittenden, 1902); Ivy City, D. C. (Coquillett, 1895 b); New Hampshire, and Sitka, Alaska (Coquillett, 1900); Maryland (Gahan, 1913); Montreal, Canada (Winn and Beaulieu, 1915); Maine (Woods).

Scaptomyza graminum Fall.

1830 *Drosophila graminum* Fall.
1847 *Drosophila sordida* Zett.
1847 *Drosophila flavipennis* Zett.
1895 *Scaptomyza vittata* Coq.

Scaptomyza graminum is a European leaf-mining species which has been mentioned many times in American literature. Howard (1896) reports it as occurring in decayed and fermenting fruit. Other writers speak of it as a leaf-miner. Sturtevant (1916) established beyond a doubt the dual habit of the species. Its operations are marked by a large, shapeless blotch, with smaller winding galleries conducting to it.

The species has a long list of host plants, which have been recorded chiefly by European workers as follows: *Anthyllis vulneraria, Aquilegia vulgaris, Cheiranthus cheiri, Diplotaxis tenuifolia, Petasites officinalis, Pisum sativum, Raphanus raphanistrum, R. sativus, Succisa pratensis, Tropaeolum majus, Tussilago farfara* (Brischke, 1880); cockle species (Chittenden, 1902); *Brassica campestris* (Coquillett, 1895 b); *Brassica oleracea* (Curtis, 1860); *Brassica rapa* (Garman, 1904); *Knautia arvensis* (Linnaniemi, 1913); *Chenopodium album, Lychnis githago, Silene armeria, Stellaria media, Viscaria oculata* (Francis Walker, 1853).

Scaptomyza graminum has been collected in England, France, Germany, and Denmark, as well as in North America. In America it ranges from Canada southward to Georgia, and from the Atlantic coast westward to Minnesota.

Family **Ephydridae**

The larvae of the family Ephydridae live in moist or acquatic situations. Many inhabit salt water or even brine. One species has been reported as living in petroleum. At least five species have been recorded as leaf-miners. Two of these, belonging to the genera Hydrellia and Notiphila, respectively, occur in North America.

The larvae differ greatly in structure. Those living in the water are elaborate creatures, superficially resembling the rat-tailed larvae of the Syrphidae. Some have prolegs, and a long, forked tail which is used to obtain air from the surface of the water. The leaf-mining species are much simpler in form, and resemble the muscid larvae. The body is cylindrical, and tapers gradually toward the anterior end and more abruptly toward the posterior end.

Genus **Hydrellia** Robineau-Desvoidy

Williston (1908) mentions that the larvae of Hydrellia mine the leaves of Lemna. Two leaf-mining species have been recorded in Europe — *H. griseola* Fall. and *H. leucostoma* Meig.

A North American species, *Hydrellia scapularis,* described by Loew (1862 b), has been recorded as a miner on the leaves of *Hordeum* species. In a recent article, De Ong (1922) states that the larvae of this species are often serious pests on rice in California.

Another species was reared by Miss Moore (1915) from the leaves of *Potamogeton amplifolius.* Miss Moore figures the mines, with the puparia, within the leaves. She figures also the mines of this or a closely related species on the leaves of *Potamogeion crispus.* Dr. O. A. Johannsen, of Cornell University, examined the larvae reared from leaves of *P. amplifolius,* and decided that they probably belonged to an undescribed species.

Genus **Notiphila** Fallén

So far as the writer is aware, there are no American leaf-mining forms in the genus Notiphila. A European species, *N. flaveola* Meig., is described in some detail by Goureau (1851). It makes blotch mines on the leaves of nasturtium and poppy.

Family **Oscinidae**

The larvae of Oscinidae have been bred from wheat, rye, and other grass stems. Two exotic species of leaf-miners have been reported — the coffee leaf-miner (*Oscinis coffeae* de Meij.), and the tea leaf-miner (*Oscinis theae* Bigot). The writer has been unable to learn anything regarding these species, and they may belong to the genus Agromyza.

It should be noted here that *Oscinis trifolii* Burgess and *O. brassicae* Riley are synonyms of *Agromyza pusilla* Meig., and are discussed under that species. *O. malvae* Burgess is a synonym of *Agromyza platyptera* var. *jucunda* V. d. W.

Family **Borboridae**

Borboridae is doubtfully recorded as a mining family through a species of Limosina which has been reported from Europe as mining in *Lappa* (*Arctium*) *major* and *Lappa* (*Arctium*) *tomentosa.* When it is considered that most of these larvae feed on dung and other decomposing matter, it is very reasonable to suppose that they were attracted by the decaying leaves and that the habits were thus confused.

Family **Cordyluridae**

For a long time the leaf-mining habit of the family Cordyluridae was based on knowledge of a single species, *Parallelomma albipes* Fall.,

mining the leaves of *Convallaria polygonâtum*. Recently, through the efforts of the European investigators Hendel (1918) and Hering (1923), other species of this family have been found to be leaf-miners. One might naturally expect this family to contain leaf-mining forms, since many of the species live in the stems of plants — a habit closely related to the leaf-mining habit.

FAMILY **Anthomyiidae**

The only leaf-mining forms of calyptrate Diptera are included in the family Anthomyiidae. They are all moderately large, and those known to be leaf-miners fall within three genera — Pegomyia, Hylemyia, and Chirosia. One other genus, Coenosia, is added here with considerable uncertainty.

Genus **Chirosia** Rondani

The writer is not familiar with the habits of the larvae of Chirosia. Two European species have been recorded, *Chirosia crassiseta* Stein and *C. parvicornis* Zett., both mining the leaves of *Pteris aquilina*.

Genus **Coenosia** Meigen

The genus Coenosia includes a species that may doubtfully be recorded as a leaf-miner, *C. bilinella* Zett. Brischke (1880) mentions *Cirsium arvense* as its food plant. Many of the species of this genus are known to inhabit filth and decaying material, and it is possible that their habits have thus been confused.

Genus **Hylemyia** Desvoidy

The genus Hylemyia comes close to Pegomyia, from which it is separated by the blackish legs and in most species the presence of three or four setae on the hind tibiae; the Pegomyia species have yellowish legs and usually only two setae on the hind tibiae. Many of the species of Hylemyia mine in the roots, stems, and leaves of plants. To this genus belong several well-known species, such as the cabbage maggot (*Hylemyia brassicae* Bouché), the onion maggot (*H. antiqua* Meig.), and the seed-corn maggot (*H. cilicrura* Rond.). So far as the writer is aware, there are only a few North American leaf-mining species in this genus.

There has been been much confusion concerning the species of Hylemyia that mine the leaves of beet, of spinach, and of several weeds belonging to the Chenopodiaceae and the Amaranthaceae. Holmgren (1880) described *H. betae*, from Europe, as a miner on beets. This species has been thrown in synonymy with *H. fugax* Meig. by Malloch (1920 a). Lintner (1882 a) found three leaf-mining species on beets. One of these he separated as a Pegomyia, and the other two he described as new species of Chortophila — *betarum* and *betae*. The writer has reared *Hylemyia fugax* Meig. from the hosts mentioned above; but until

comparisons can be made with Lintner's types, it is impossible to determine how many leaf-mining species there are in Hylemyia.

Both Lintner's and Holmgren's descriptions are too meager for making determinations. There is no doubt, however, that Holmgren had a true species of Hylemyia, for his description reads, in substance: Eyes in male contiguous, in female separated, legs wholly black. From Lintner's description one can likewise be certain that he was dealing with a species of Hylemyia.

Hylemyia fugax Meig.

1838 *Anthomyia striolata* Zett.
1862 *Anthomyia fugax* Meig.
1866 *Anthomyia pudica* Rond.
1880 *Aricia betae* Holm.
1920 *Hylemyia denticauda* Mall.

Hylemyia fugax is a fairly common miner on the leaves of spinach and beet and on the leaves of several weeds. Lintner's two species *betae* and *betarum* may be synonymous with *fugax,* but until comparisons are made with the types there can be no certainty as to this point. *H. betae* of Curtis (1847) belongs to the genus Pegomyia and is a synonym of *P. hyoscyami* Panz.

In the vicinity of Ithaca, New York, *Hylemyia fugax* is not exceedingly abundant. Only an occasional adult was reared, while many specimens of *Pegomyia hyoscyami* were reared from the same host plants. About Washington, D. C., and Arendtsville, Pennsylvania, *Hylemyia fugax* was found more abundant. In New York the species is not a serious pest on beets or spinach because of its relative scarcity and its preference for *Chenopodium album* as a host. There is no doubt that it has a more southerly distribution. Collections do not wholly bear this out, but it is indicated by the increase in abundance as one goes southward. The species has probably been overlooked in many localities, or has been confused with the commoner species *Pegomyia hyoscyami.*

In addition to its occurrence in Sweden (Holmgren, 1880), *Hylemyia fugax* has the following distribution in America: Maine, Massachusetts (Boston), Connecticut, and New York (Middletown), recorded by Lintner (1895); Ithaca, New York, Washington, D. C., and Arendtsville, Pennsylvania, observed by the writer.

Spinacia oleracea was the host originally recorded by Holmgren (1880) for this species, which he called *Aricia betae. Beta vulgaris* was the host recorded by Lintner (1882 a), and he called the species *Hylemyia betarum* Lintner. In addition to these host plants, the writer has *H. fugax* from *Chenopodium album* and *Amaranthus retroflexus.* The former was found to be the favorite food plant of the larva.

A few records on the incubation period of the eggs in this species (table 10) indicate that from eleven to fourteen days elapse between the time when the eggs are laid and the date when they hatch. Eggs were found in abundance from June 5 to June 22, but after the latter

TABLE 10. LENGTH OF INCUBATION PERIOD IN HYLEMYIA FUGAX

Date when eggs were laid	Date when eggs hatched	Length of incubation period (days)
June 10	June 24	14
11	25	14
14	25	11
14	25	11
14	28	14

date it was difficult to find them. By the middle of the summer no larvae could be found. From these facts it was concluded that the species has but one generation in a season, and that its activities occur only during the early part of the summer. The eggs are laid singly, not in groups as in Pegomyia. They are white, elongate, smooth, and glistening, and are without reticulations or markings.

The mines are at first linear and very short, from three-fourths of an inch to an inch in length. These short mines are frequently curved and script-like. Later they broaden out into the blotch mine and cannot be distinguished from those produced by the larvae of *Pegomyia hyoscyami*.

The larvae abandon the leaves to transform, and the adults issue about sixteen days after the formation of the puparia.

Larva.— Length, when full-grown, 8 to 10 mm. Body cream-colored. Posterior end distinctly tuberculate. Edges of segments on ventral aspect beset with several rows of minute locomotory spines, these nearly encircling anterior margins of first segments. Anterior spiracles semicircular, with from nine to ten breathing pores. Posterior spiracles with three oval radiating breathing pores. Mandibular sclerite in first instar triangular, stout, and with minute or no teeth; mandibular sclerite in second instar with a single tooth. Anus opening between two broad semichitinized plates. Posterior tubercles long, prominent, surrounding the spiracles in more or less of a circle; four pairs of these tubercles, one pair above, one pair below, and two lateral pairs; in addition to these, a pair of tubercles posterior to anal plate on ventral aspect of last segment.

Hylemyia nigrescens Rond.

1877 *Hylemyia nigrescens* Rond.

Hylemyia nigrescens has been reported from Europe as a leaf-mining form on *Dianthus caryophyllus*. It has been collected in America without reference to its habits. Little is known concerning its life

history. Collinge (1912) says: "The eggs are laid on the leaves, and on hatching, the tiny larvae burrow into the tissues, and make their way into the stem, where they feed upon the pith." Linnaniemi (1913) calls the insect the *carnation fly*.

Hylemyia substriata Stein

1898 *Hylemyia substriata* Stein

Still another species, *Hylemyia substriata*, has been reared from the leaves of mangold and beet. The writer has reared it at Ithaca and in the vicinity, and H. C. Huckett has collected it from various localities on Long Island.

Hylemyia transversalis Zett.

1845 *Aricia transversalis* Zett.

Hylemyia transversalis was recorded by Inchbald (1881 a) as a leaf-miner on *Rumex acetosa*. It is apparently a common species in Europe, but it has not been recorded from America, so far as the writer is aware, and very little is known concerning its habits.

Genus **Pegomyia** Desvoidy

The genus Pegomyia is not well defined. It is characterized by the narrow front in the male, the possession of one post-humeral, the equal squamae, the pubescent or bare arista, the posterior tibiae usually with only two preapical bristles, and the legs being yellow or yellowish, at least in part. Pegomyia runs close to Hylemyia, in which the arista is plumose or subplumose, the legs are black, and the hind tibiae have three or four preapical bristles.

Pegomyia is, for a large part, a mining genus. Some of the species mine in the roots of plants, and others in the stems; but the majority mine in the leaves. Réaumur (1737) says, in substance, that the cradle of these Diptera is in the interior of the leaves. His attention was evidently called only to the leaf-mining forms. One species has been found in nests with gophers; another has been bred from mushrooms. Fifteen authentic leaf-mining species have been recorded from various parts of the world. Only six of these are known to occur in America, the remainder being European species. Polygonaceae and Chenopodiaceae are the preferred hosts of this genus.

The characters by which the American leaf-mining species of Pegomyia can be separated in their egg and larva stages, respectively, are summarized in tables 11 and 12. *P. ruficeps* and *P. winthemi* are omitted from the list because material was not available, and *P. nigritarsis*, a European species, is added for comparison. In compiling these tables the writer had at hand abundant material of the eggs, the larvae, and the adults of *P. vanduzeei* Mall., *P. calpyptrata* Zett., and *P. hyoscyami* Panz. In addition he had adults of *P. winthemi*, *P. bicolor*,

and *P. nigritarsis*. The characters for the immature stages of *bicolor* and *nigritarsis* were taken from Cameron (1914).

TABLE 11. DISTINGUISHING CHARACTERISTICS OF THE EGGS OF NORTH AMERICAN LEAF-MINING SPECIES OF PEGOMYIA

Species	Color	Shape	Reticulations
vanduzeei Mall.	White, waxy	Rounded at both ends	Rectangular
bicolor Wied.	White, waxy	Rounded at both ends	Rectangular
calyptrata Zett.	White, glossy	Pointed at one end	Polygonal
hyoscyami Panz.	White, waxy	Pointed at one end	Rectangular (delicate)
nigritarsis Zett.	White, waxy	Pointed at one end	Rectangular

TABLE 12. DISTINGUISHING CHARACTERISTICS OF THE LARVAE OF NORTH AMERICAN LEAF-MINING SPECIES OF PEGOMYIA

Species	Color of body	Number of teeth on mouth hooks	Length (mm.)	Sensory papillae	Anterior spiracles	Postcephalic ventral tubercle	Tubercles of posterior segment
vanduzeei Mall.	Dirty white, dull	4	9	Not close together, about same size as antennae	20 to 25 lobes	Absent	(?)
bicolor Wied.	Yellow, shiny	3	10	Close together, same size as antennae	25 to 30 lobes	Present	3 pairs
calyptrata Zett.	Yellow, shiny	3	9.5	Close together, smaller than antennae	25 to 30 lobes	Present	(?)
hyoscyami Panz.	Dirty white	5	8.5	Not so widely separated as antennae	8 lobes	Absent	7 pairs
nigritarsis Zett.	White, dull	?	9.5	Same distance apart as antennae	16 to 25 lobes	Absent	6 pairs

Two of the docks, *Rumex crispus* and *R. obtusifolius*, are extensively mined by several species of Pegomyia. Among these are two, *P. calyptrata* Zett. and *P. vanduzeei* Mall., which occur commonly throughout the United States. *P. calyptrata* is by far the commoner of the two species. The adult is readily distinguished by a bluish gray thorax and a reddish yellow abdomen. *P. vanduzeei*, on the other hand, is less common. It occurs about Ithaca, New York, abundantly in the early summer, but later in the season neither eggs, larvae, nor adults have been found. This species is distinguished by its inconspicuous gray color. *P. calyptrata* and *P. vanduzeei* are discussed at length in succeeding pages.

There are at least two other species of Pegomyia occurring in this country, which mine *Rumex* species — *Pegomyia bicolor* Wied. and *P. winthemi* Meig. These occur in the northern United States and Canada, but do not appear to be common at Ithaca.

Pegomyia bicolor Wied.

1817 *Anthomyia bicolor* Wied.
1826 *Anthomyia solennis* Meig.
1826 *Anthomyia mitis* Meig.
1834 *Anthomyia rumicis* Bouché
1851 *Zabia longipes* R-D.

The habits of *Pegomyia bicolor* Wied. are not very well known. Cameron (1916–17) conducted some experiments on the breeding of this species, which he published in connection with his breeding experiments on *Pegomyia hyoscyami* Panz. The writer has noticed considerable color variation among the flies. Some specimens have the center and the tip of the scutellum, as well as the humeral callosities, yellowish. In these the second joint of the antenna and the basal part of the third antennal joint also are yellowish. In other specimens the scutellum and the humeral callosities are concolorous with the pronotum, and the third antennal joint is uniformly dark brown with the second joint but slightly lighter.

The species has been reared from the leaves of *Cirsium palustre*, *Rumex crispus*, *R. obtusifolius*, and *Stellaria media*. The writer has never reared nor collected it in the vicinity of Ithaca, New York.

P. bicolor occurs in Europe and is recorded from England, Denmark, and Germany. It has been recorded also from Wooster, Ohio, from Minnesota, and from Quebec, Canada.

Pegomyia calyptrata Zett.

1846 *Pegomyia calyptrata* Zett.

Pegomyia calyptrata was first described by Zetterstedt (1846). Since that time there have been but few references to it. P. Stein (1898), Pandellé (1901), and Bezzi and Stein (1907), refer to this species, but mention nothing regarding its habits. The species has undoubtedly been noticed by many but its identity has been

unknown. In looking over some unidentified material in the collection at Cornell University, the writer found specimens reared by Professor Comstock as early as 1882.

Pegomyia calyptrata mines exclusively in the leaves of several species of Rumex. Adults have been reared from *Rumex obtusifolius* and *R. crispus*. Both of these species are equally susceptible to the attack of the miner. *R. acetosa* is evidently a third host, eggs of *Pegomyia calyptrata* having been found on this plant. These eggs hatched and the young larvae entered the leaf, but the writer did not succeed in rearing adults. A large number of adults of other Pegomyia species were reared from larvae mining the leaves of garden beets, spinach, and swiss chard, as well as many weeds, such as *Chenopodium album*, *Amaranthus retroflexus*, and *Atriplex patula*; but *Pegomyia calyptrata* was not obtained from any of these.

A number of experiments were performed to induce the larvae of *P. calyptrata* to mine in the leaves of other plants. Three eggs were carefully removed from a dock leaf and placed on a beet leaf. The eggs hatched, but the larvae refused to enter the beet leaf. In a second experiment, four second-stage larvae were dissected from *Rumex obtusifolius* and placed on *Chenopodium album*. On the following day the four larvae were found dead. In a third experiment, two third-stage larvae from *Rumex crispus* were placed on *Chenopodium album*. By the following day one larva had entered the leaf and formed a small blotch mine, but on the next day the larva died. These experiments seem to substantiate the belief that *Pegomyia calyptrata* mines solely in *Rumex* species.

The species occurs in Europe as well as in America, although it appears to be exceedingly rare in Europe. P. Stein (1906) neglects to list this species in his paper. Zetterstedt (1846) mentions its occurrence in Sweden, stating that one specimen was taken near Lund by D. Dahlbom and a second at Wadstena by himself. Two specimens were taken at Altenburg, Germany. In America the species is a common one, especially in New York State, where the writer has found it widely distributed. P. Stein (1898) mentions its occurrence in Washington, Minnesota, Illinois, Pennsylvania, and Massachusetts. To these localities the writer adds New Jersey and New York, he having taken the species at Ithaca, Binghamton, and Tarrytown, New York, and Orange, New Jersey.

Life history and habits.— The eggs are seldom laid singly, but are usually in groups of from three to five, or occasionally in groups of six or seven. They are normally placed in neat transverse rows on the under surface of the leaf. Eggs laid in captivity, however, are scattered over both surfaces of the leaf, and frequently are laid singly instead of in groups.

The number of eggs occurring on a single leaf is surprising. As a rule one finds only five or six groups, but it is not uncommon to find more. In one instance the writer found twenty groups of eggs on a single leaf, 65 eggs in all. On another leaf, 16 inches long, he found eighteen groups containing 47 eggs. It is interesting to note that not all the larvae from these eggs matured within the leaf on which they were laid, but some migrated and started new mines on other leaves.

The length of the egg stage is shown in table 13:

TABLE 13. LENGTH OF EGG STAGE IN PEGOMYIA CALYPTRATA

Experiment no.	Date when eggs were laid	Date when eggs hatched	Length of egg stage (days)
A-112	May 7	May 13	6
A-111	8	14	6
A-113	15	20	5
A-117	8	14	6
A-122	16	22	6
A-129	23	25	2
A-132	26	30	4
A-116	14	19	5
A-5	14	17	3
A-134	27	30	3
A-141	31	June 5	5
A-15	June 23	26	3

The eggs hatch in from two to six days and the young larvae immediately enter the leaf, making small holes through the lower epidermis. All the eggs of a single group hatch at the same time and the larvae feed in a common mine, which is at first linear. The larvae mine side by side, progressing only in a forward direction. They keep close together, and all change their direction of mining at the same time, leaving behind them a short linear path. In about a day, although no definite time can be set, the larvae begin to enlarge their mine laterally, forming a blotch. They still remain in a common mine but separate in different directions. It is not an unusual sight to see several such blotches on a leaf. Each represents the work of a number of larvae that have hatched from a single group of eggs. These mines increase in size until they interfere with one another and a large blotch is produced covering the entire area of the leaf. Many of the larvae are naturally forced to abandon their mines and form new ones in other leaves. The presence of nearly mature larvae in small blotch mines is an indication that these larvae have entered fresh leaves.

The writer has removed a larva from its mine and watched it form a new one. The process is as follows: At first the larva cuts a short slit in the epidermis of the leaf. Then, by inserting its mouth hooks in this slit and working them back and forth, it separates the lower and upper epidermal layers of the leaf. The larva then pushes the anterior end of its body into the small opening that it has made. After the first two segments have been forced through the opening, it is only a matter of a few minutes before the larva has worked its way completely within the leaf. This operation is accomplished with many vigorous twists of the body as it is drawn into the leaf. Larvae of the third instar bury themselves completely in the leaf in less than twenty minutes.

The feeding habits of the larva are most interesting and can be very conveniently watched under a microscope by means of transmitted light. The pharyngeal skeleton, bearing the mouth hooks, is loosely joined within the first and second segments and is capable of great freedom of movement. The mouth hooks move very rapidly when the larva is feeding, and are very effective tools for tearing away the parenchyma of the leaf. There are two distinct types of movement which the mouth hooks possess. The first is a lateral movement, in which the hooks are turned perpendicular to their normal position and work in the plane of the mine. They strike to the right for a short time, then to the left, separating the upper and lower epidermal layers but not tearing away any of the tissue. The second movement of the hooks is a vertical one. As the hooks are held in their normal position they are thrust downward, and pieces of the parenchyma are torn loose from the bottom of the mine. In the first movement the two epidermal layers are only separated; in the second, the parenchyma of the leaf is actually removed.

As shown in table 14, the length of the larval period varies somewhat. This variation is undoubtedly due to weather conditions. In warm weather the larvae mature rapidly, but in cooler weather they become inactive and the larval period may be prolonged for several days. Unfortunately the table is not complete enough to show this. However, it shows a tendency for a shorter larval period toward the middle of summer, and a longer period toward fall.

TABLE 14. LENGTH OF LARVAL PERIOD IN PEGOMYIA CALYPTRATA

Experiment no.	Date when eggs hatched	Date when puparium formed	Length of larval period (days)
A-126	May 23	June 7	15
A-129	25	10	16
A-135	29	8	10
A-35	July 3	July 12	9
A-225	October 8	October 21	13

The mature larvae escape through the epidermis of the leaf but seldom make their exit through a definite hole. Usually the upper epidermis becomes dry and parchment-like, rupturing itself and allowing the larvae to escape. In some cases, however, the larvae cut circular holes through the epidermis. They fall to the ground and ordinarily penetrate the soil to a depth of two or three inches. If the ground is hard they do not enter, but form their puparia beneath leaves or other rubbish. The depth to which the larvae penetrate varies considerably. To determine this a few experiments were performed with full-grown larvae. A root cage was used, which had a space of a quarter of an inch between the glass and the back. This space was filled with loose sandy soil. The surface of the soil was covered, to prevent the larvae from escaping. This darkened the top of the soil and altered conditions a trifle. Twenty-seven mature larvae were placed on the surface of the soil. On the following day eight puparia were found on the surface; the remainder of the larvae either had failed to transform or had escaped. In a second experiment, thirty-two mature larvae were placed on the surface of the soil. Four of these larvae transformed on the surface, six were found at a depth of five inches, and two were at a depth of six inches. These experiments, though few in number, give some idea of the depth to which the larvae penetrate loosely compacted soil.

In captivity many of the larvae formed their puparia within the leaves. Mined leaves were collected in large numbers and put into receptacles, to obtain puparia. In most cases the puparia were found in the leaves or between the leaves from which they had issued. A few of the larvae wandered about in an attempt to find a more suitable place in which to transform. Evidently many of the larvae under natural conditions never enter the soil.

It is seen in table 15 that some of the puparia formed in June and July, as well as those formed in September, did not transform to adults in the same year that they were formed, but overwintered as puparia and the adults issued in the following spring. This seems to be a provision of nature to insure the continuation of the race in the following year, in case all the individuals of any generation should perish.

TABLE 15. LENGTH OF PUPARIAL STAGE IN PEGOMYIA CALYPTRATA

Experiment no.	Number of puparia	Date when puparia formed	Date when adults issued	Number of adults	Length of puparial stage (days)
A-150	6	June 5	July 1	1 ♀	26
A-168	4	9	July 5	2 ♀	26
		9	July 6	1 ♀	27
A-165	29	9	July 1	6 ♂	22
		9	July 3	1 ♀	24
A-9	4	11	July 6	1 ♂	25
A-14	10	11	July 3	4 ♂	22
		11	July 4	3 ♀	23
A-167	29	13	July 3	1 ♂	20
A-169	10	13	July 5	1 ♀	22
A-182	17	16	July 3	1 ♂ 3 ♀	17
A-17	3	25	July 16	1 ♂	21
		25	May 6*	1 ♀	316
A-27	3	July 16	August 5	3 ♂	20
A-26	5	17	August 6	1 ♂	20
		17	August 8	1 ♂	22
		23	August 13	1 ♂	21
A-28	8	23	August 14	1 ♂	22
		23	May 4*	1 ♀	286
		27	August 14	2 ♂	18
A-31	6	27	August 16	1 ♀	20
		27	May 5*	1 ♀	283
		29	August 15	2 ♂	17
A-32	17	29	August 16	1 ♀	18
		29	August 18	2 ♂	20
A-34	4	30	August 17	1 ♀	18
A-36	11	August 1	August 25	1 ♀	24
A-37	9	1	August 20	2 ♂	19
		1	August 21	1 ♀	20
		7	August 30	1 ♀ 1 ♂	23
A-43	6	7	August 31	1 ♀	24
		9	August 29	1 ♀	20
A-188	53	9	August 30	1 ♂	21
		9	Sept. 1	1 ♀ 1 ♂	23
A-190	18	9	Sept. 1	1 ♀	23
A-52	2	12	August 30	1 ♀	18
A-60	6	21	Sept. 11	1 ♂	21
		21	Sept. 13	1 ♀	23
A-74	5	Sept. 2	May 6*	1 ♀	247
A-77	2	3	May 5*	1 ♀	245
A-78	3	4	May 4*	1 ♂	243
		4	May 5*	1 ♀	244

* Adults issued the following year from puparia kept out of doors over winter.

TABLE 15 (*concluded*)

Experiment no.	Number of puparia	Date when puparia formed	Date when adults issued	Number of adults	Length of puparial stage (days)
		Sept. 17	Oct. 9	2 ♂ 4 ♀	22
		17	Oct. 11	2 ♂ 1 ♀	24
A-93.....	71	17	May 4*	6 ♂ 2 ♀	230
		17	May 5*	3 ♀	231
		17	May 6*	1 ♂	232
A-97.....	23	29	Feb. 14†	1 ♂	138
		Oct. 10	May 4*	1 ♂	207
		10	May 5*	2 ♀	208
A-102.....	16	10	May 6*	1 ♀	209
		10	May 7*	1 ♀	210
		18	May 4*	1 ♂	199
A-107.....	(?)	18	May 13*	1 ♂	208
		18	May 16*	1 ♂	211

* Adults issued the following year from puparia kept out of doors over winter.
† Adults issued the following year from puparia kept indoors over winter.

While working with the adults the writer had an opportunity to experiment with several types of rearing cages. A cage similar to the Riley cage, covered with cheesecloth on three sides and with glass on the fourth, gave good results with large numbers of flies but proved useless for individual pairs. Glass cylinders yielded better results for this purpose, but were unsatisfactory because the adults escaped when the cylinders were lifted. The most satisfactory type of cage proved to be the Fiske cage, which is used to a considerable extent in the rearing of parasites by the Bureau of Entomology of the United States Department of Agriculture in its work at Melrose Highlands, Massachusetts. The small opening at the top readily permits a person to introduce food, while the ring at the bottom prevents the flies from escaping.

In spite of all the precautions used in handling and feeding the adults, they did not live long in captivity. One male was kept alive for eighteen days. The length of life of males and females, as ascertained from pairs that were kept in captivity, is given in table 16:

TABLE 16. LENGTH OF LIFE OF ADULTS OF PEGOMYIA CALYPTRATA

Females			Males		
Date of issuing	Date of death	Length of life (days)	Date of issuing	Date of death	Length of life (days)
May 6	May 11	5	July 2	July 5	3
July 3	July 19	16	3	21	18
July 6	8	2	Aug. 16	Aug. 23	7
19	20	1	16	22	6
20	27	7	16	22	6
Aug. 16	Aug. 23	7	22	Sept. 2	11
16	24	8	26	Aug. 30	4
22	Sept. 2	11	31	Sept. 7	7
26	Aug. 30	4	Sept. 1	3	2
31	Sept. 10	10	Oct. 10	Oct. 12	2
Sept. 1	3	2			
23	28	5			
Oct. 10	Oct. 12	2			

Twice the writer observed adults issuing feet first from the puparia, which is an unusual occurrence. One of these flies succeeded in freeing itself from the puparium, but its wings never expanded normally. The other fly broke through the puparium with its feet, but did not succeed in working itself free.

Copulation frequently takes place a few hours after the females have issued. Flies that had issued during the night were observed, in several cases, to copulate during the following morning. Good results in observing copulation were obtained by placing the pairs in six-dram vials. The flies could thus be conveniently watched, and mating took place fairly readily. Pairs that were in larger cages usually died before copulation took place. Copulation usually lasted about forty minutes; in one case, however, it lasted an hour and fifteen minutes. It is still unknown whether a second or later copulations take place.

The number of eggs laid was ascertained only by dissection. About sixty-two ripe eggs were found in a fertilized female. Evidently all the eggs are laid in one oviposition period.

Number of generations.— The writer has been unable to determine accurately the number of generations in a year for this species. This is due to the repeated difficulty which he experienced in attempting to keep the adults alive for any considerable period, as well as to his failure to induce females to oviposit. Only four of the many females with which the writer experimented laid eggs, and, of these four, none

laid more than five eggs. Under such conditions it was impossible to rear the generations through from eggs to adults. However, the number of generations was followed fairly accurately by observing conditions in the field and comparing them with conditions under observation at the insectary.

The various generations overlap one another, and it is impossible to tell, under natural conditions, when one ends and another begins. The termination of the first generation can be easily observed. For example, in the spring of 1916 the first flies to issue from puparia kept out of doors over winter, appeared on May 4. The adults continued to issue until May 16. The females began laying soon after emerging; those that issued from puparia in captivity began in four or five days. This checks with conditions in the field, for there the first eggs were observed on May 7. The larvae matured in from nine to sixteen days. Toward the end of the larval period they mined rapidly, producing conspicuous blotches on the leaves. The maturing of the first-generation larvae could thus be easily distinguished. After this it was impossible to follow the individual generations by observation in the field alone. One can go out to the field at any time during the summer and find eggs, larvae, pupae, and adults all at the same time.

From a number of the eggs laid in spring by females that had overwintered as puparia, the writer succeeded in rearing adults of the first generation. These adults laid a few eggs but none of them hatched. From eggs brought in from the field at this time, the writer reared adults of the second generation. This was continued throughout the summer and a fair idea of the number of generations was thus obtained. During 1915 and 1916 the writer found three generations and a partial fourth. The majority of the fourth generation were overtaken by the cold weather, and perished.

Parasites and predacious enemies.— The writer reared two parasites from the puparia of *P. calyptrata* — *Opius quebecensis* Prov. and *Dacnusa scaptomyzae* Gahan.[5] Several times the writer observed the Dacnusa ovipositing in the larva of the miner. When the parasite alights on the mine the larva becomes uneasy and gives several twists in an attempt to avoid the attack. Unfortunately the larva is pinned between the two epidermal layers of the leaf, and has little freedom of movement. Thus it is a simple matter for the parasite to insert its ovipositor into the larva. The parasites transform within the puparia and issue somewhat later than the flies themselves.

A third parasite, *Trichogramma minutum* Riley,[6] was reared from the eggs of this species. Six parasites issued from three eggs, indicating very clearly that more than one parasite develops within a single egg.

[5] Both determined by A. B. Gahan, of Washington, D. C.
[6] Determined by A. A. Girault.

In addition to these parasites, a larva of this leaf-miner was attacked by an adult *Nabis ferus* L. The writer also caught a nymph of this species with its beak inserted into the larva of the miner, sucking out the juices from its body. *Nabis ferus* L. is a predacious species and has been known to attack also the larva of *Pegomyia hyoscyami* Panz., the spinach leaf-miner.

Descriptions of stages

Egg.— Length 1.18 mm.; width 0.35 mm. Dirty white, glossy, elongate, and nearly cylindrical. Surface reticulated, composed of polygonal areas. Micropyle end rounded or slightly flattened, the opposite end distinctly pointed.

First-instar larva.— Length 1.3 mm. Body creamy white in color and more or less transparent, the trachea and the alimentary canal being visible through the integument for the whole length of the body. Twelve visible segments, but segmentation not distinct. Body rather smooth except for the minute fleshy locomotory spines, which are located on intersegmental areas and margins of each segment posterior to second; these fleshy spines arranged in discontinuous, thickly set rows encircling the body, slightly oblique to edges of segments. First segment, or "pseudo-cephalon" (Henneguy), bearing a pair of sensory papillae a short distance in front of mouth opening. On each side of "pseudo-cephalon," a row of twelve or thirteen minute button-like areas extending dorsally from mouth opening. Pharyngeal skeleton slender and not so highly chitinized as in the later instars. Mandibular sclerite elongate and serrated, with about twelve sharp teeth. Anterior spiracles closed. Posterior spiracles with single breathing pores. Posterior ends of trachea slightly chitinized and appearing as two parallel chitinized bars at posterior end of larva, more conspicuous than the spiracles themselves.

Second-instar larva.— Segmentation more conspicuous than in first instar. Alimentary canal and trachea becoming obscured by the accumulation of fat, and larva becoming more yellowish in color. "Pseudo-cephalon," as in preceding stage, bearing a pair of sensory papillae, and, in addition, a pair of two-segmented antennae, which are located slightly posterior to the papillae and are not so closely approximated as these. Pharyngeal skeleton longer and more highly chitinized than in preceding instar. Mandibular sclerite triangular, and bearing four teeth. Button-like areas on side of "pseudo-cephalon" present, but reduced to five in number. As in the first-stage larva, intersegmental areas, and edges of segments posterior to second, encircled by several discontinuous rows of minute fleshy locomotory spines, these becoming less pronounced posteriorly. An anterior spiracle on each side inserted between second and third body segments. Each spiracle with from twenty-four to twenty-six breathing pores arranged about an oval, slightly chitinized, flattened disk. Posterior spiracles projecting slightly, and having two narrow breathing pores. Anus opening between two triangular plates on venter of last segment.

Third-instar larva.— Length when mature, 9 to 9½ mm. Body yellowish in color, and distinctly shiny and bead-like in shape especially when viewed from above. A reddish area within anterior end, which disappears when larva is preserved in alcohol. "Pseudo-cephalon," as before, bearing a pair of two-jointed antennae in front of mouth opening, and in front of these a pair of sensory papillae. Five minute button-like areas present on sides of "pseudo-cephalon." Pharyngeal skeleton even more highly chitinized than in second-stage larva, but bearing three teeth. Intersegmental areas, and edges of third to last body segment, encircled with minute fleshy locomotory spines, as in previous stages. Posterior spiracles borne on short tubercles and having three breathing pores. Anus opening between two triangular, partly chitinized plates.

TABLE 17. DISTINGUISHING CHARACTERS OF THE LARVAL STAGES OF PEGOMYIA CALYPTRATA

Characters	First stage	Second stage	Third stage
Reddish area at anterior end	Absent	Absent	Present
Sensory papillae	Absent	Present	Present
Button-like areas on side of "pseudocephalon"	12 to 13	5	5
Pharyngeal skeleton	Slender, weakly chitinized	Stout, strongly chitinized	Stout, strongly chitinized
Mandibular sclerite	Elongate, serrated, 12 teeth	Triangular, with long basal projection, 4 teeth	Triangular, basal projection short, 3 teeth
Anal spiracle	One breathing pore	Two breathing pores	Three breathing pores

Puparium.—Yellowish when first formed, with reddish area at anterior end corresponding to that found in larva. This colored area soon disappearing, and in about two hours puparium becoming reddish brown in color. Divisions of segments marked by a grayish powdery substance. Surface of segments marked by fine annular striae. Triangular plates of larva visible in puparium. Adult, in issuing, breaks a piece from anterior dorsal part of puparium, including first, second, and third segments, and some of fourth. Anterior spiracles of larva removed with cap, which is broken loose. Mouth hooks of third-stage larva seen attached to inner ventral wall of puparium.

Pegomyia hyoscyami Panz.

1809 *Pegomyia hyoscyami* Panz.
1809 *Pegomyia laemonhou* Panz.
1825 *Anthomyia conformis* Fall.
1826 *Anthomyia conformis* Meig.
1826 *Anthomyia hyoscyami* Meig.
1826 *Anthomyia egens* Meig.
1826 *Anthomyia exilis* Meig.
1849 *Anthomyia betae* Scholtz
1851 *Pegomyia gouraldi* R-D.
1851 *Pegomyia striplicis* Gour.
1866 *Chortophila effodiens* Rond.
1866 *Chortophila perforans* Rond.
1866 *Chortophila cunicularis* Rond.
1866 *Anthomyia chenopodii* Rond.
1872–74 *Anthomyia polygoni* Kalth.
1881 *Pegomyia vicina* Lint.

Varieties:

1847 *Anthomyia hyoscyami betae* Curt.
1849 *Anthomyia hyoscyami dissimilipes* Zett.
1880 *Anthomyia hyoscyami spinaceae* Holm.
1880 *Anthomyia hyoscyami femoralis* Brischke
1900 *Pegomyia hyoscyami n. trejbinhensis* Strobl
1900 *Pegomyia hyoscyami nigricornis* Strobl

Pegomyia hyoscyami is known under the following common names: beet leaf-miner (Lintner), spinach leaf-miner (Sirrine), belladonna leaf-miner (Cameron), beet-leaf Pegomyia (Howard). The large number of host plants has led to its description by various authors under different names. The synonymy used by Cameron (1914) and by Cory (1916 a) is followed in this paper.

The species was first described by Panzer (1809). He at that time noted the mining habit of the larvae on the leaves of *Hyoscyamus niger*. More than a half-century before this, however, Réaumur (1737) had mentioned and figured a larva mining *Hyoscyamus niger*. This, as pointed out by several authors, was evidently the same species as that described by Panzer. Chevrel (1892) was the first to mention the species as an economic one, and he published a rather complete paper on its life history and control. For a review of the European literature, the reader is referred to Cameron (1914).

In America *P. hyoscyami* has been known for only a comparatively short time. It was first reported from Middleburg, New York, in 1881, and was recorded by Lintner (1882 a) under the name *P. vicina* n. sp. There is, however, good reason to believe that it was present in the United States for some years before this date. The fact that it was recorded in the same year from Morrisville and Middleburg, New York, and from Bennington, Vermont, indicates that it must have been in the country for some time previous to 1881. In 1886 the species was again reported by Lintner from Middletown, New York. For a period of about ten years following these records, there are no accounts of injuries by this insect in America. At the end of that time Sirrine (1896) reported serious damage to the spinach crops in New York. In the same year reports came from Rhode Island that spinach was being seriously injured by this species. Stone (1899) reported a serious outbreak on sugar beets at Ithaca, New York. Smith and Dickerson (1912) reported attacks by the beet leaf-miner at Richfield and New Brunswick, New Jersey. During the summers of 1915 and 1916 the writer received many reports of serious outbreaks throughout New York. It appears that the pest is steadily increasing in abundance and importance.

The species has a great variety of food plants, including many weeds. Among the cultivated plants are *Atriplex hortensis*, *Beta cicla*, *B.*

vulgaris, and the mangel-wurzel. The plants attacked or reported as host plants fall in seven families — Chenopodiaceae, Polygonaceae, Amaranthaceae, Solanaceae, Compositae, Caryophyllaceae, and Rosaceae; the last-named three are doubtful, but plants of these families have been recorded as hosts. The host-plant species reported are as follows: *Polygonum amphibium, P. persicaria, Stellaria media* (Brischke, 1880); *Amaranthus retroflexus* (Chittenden, 1911); *Atropa belladonna* (Chevrel, 1892); *Sonchus arvensis* (Collinge, 1912); mangel-wurzel (Curtis, 1860); *Atriplex hortensis* (Desvoidy, 1851); *Spinacia oleracea* (Holmgren, 1880); *Solanum dulcamara* (Imms, 1915); *Chenopodium album, C. murale* (Kaltenbach, 1872–74); *Solidago virgaurea* (Linnaniemi, 1913); *Arctium lappa* (Lintner, 1882 a); *Hyoscyamus niger* (Réaumur, 1737); *Beta vulgaris, Sonchus oleraceus* (Robineau-Desvoidy, 1830); *Datura stramonium, Onopordum acanthium, Silene* species, *Spiraea species* (Vasiliev, 1915 b); *Carduus* species, *Taraxacum officinale* (Whitehead, 1893); *Atriplex patula, Beta cicla* (the writer).

P. hyoscyami is widely distributed in Europe and America. It has been recorded also from eastern Canada. In Europe it has been recorded from Denmark, Sweden, England, Ireland, Scotland, Germany, Spain, and Russia.

The life history and the habits of this species are described in some detail in the following pages.

Egg laying.—The eggs are laid on the under surface of the leaf, in groups of from three to five. In the writer's work no eggs were found on the upper leaf surface except those that were laid in captivity. Usually there are but three or four groups of eggs on a single leaf, but on some leaves fifteen or twenty groups are found. In the early spring the writer has seen small spinach leaves so thickly covered with eggs as to have a whitish appearance from below. On one leaf seven-eighths of an inch long, ten eggs were counted. The eggs are usually laid in very neat and regular parallel rows. Occasionally, however, they are laid irregularly, and then they present a very different appearance. At first the female selects the more tender and more succulent leaves as a place for egg-laying, but later the older and hardier leaves are attacked.

Few observers have succeeded in ascertaining the reproductive capacity of the female of the beet leaf-miner, or, in fact, of any species of Anthomyiidae which has yet been studied. By rearing, Cameron (1914) obtained thirty-two eggs laid by one female, and he states that "perhaps forty would be a very low estimate"; by dissection, he found twenty-two eggs ready for oviposition. Observations at Ithaca indicate that the reproductive capacity of the female is considerably higher than as stated by Cameron. Although little success was experienced in getting females to oviposit in confinement, a few egg-lay-

ing records were obtained. From eighty pairs of flies that were under observation, the writer made the following notes: eleven of the females oviposited, laying from seven to seventy eggs; two of the females laid sixty-six and seventy eggs, respectively, the former laying over a period of fourteen days, the latter over a period of three days. In order to obtain further data on the possible number of eggs laid, females were dissected at intervals of eight and thirteen days, respectively, after emergence. From fifty to sixty ovarioles were found, each of which contained a single ripe egg. It seems, therefore, that the number of eggs laid by the two females with the highest egg-laying record in table 18 — D-54 and D-11 — represents the total number of eggs laid by these females at the first oviposition period. The fact that the females which were dissected showed maturing eggs as well as fully matured eggs at the end of each ovariole, indicates that a later oviposition period may occur. The number of eggs laid by some of the females in confinement is shown in table 18, together with the period over which the eggs were laid.

Incubation period of the eggs.— Many and varied opinions have been expressed on the incubation period of the eggs of *P. hyoscyami*. Undoubtedly there is some difference in the length of this period in different parts of the country, and an even greater difference in other parts of the world. Records varying from three to eight days have been noted in the literature. Several European workers mention that the egg period is longer in Europe than in America; there seems, however, to be but little difference. Farsky (1880) placed the egg stage at from six to eight days. Cameron (1914), from ten experiments in which the eggs were carefully tagged when laid, found the incubation period to be from five to six days. Howard (1895) ascertained the incubation period by collecting 2000 eggs in the field and determining the average of the time in which they hatched. In this way he found the egg stage to be from three to four days. The writer obtained several records by tagging beet leaves as soon as the eggs were laid, and he found the period to be from four to five days.

The larva.—The larva leaves the egg through a small hole on the under side at the micropylar end. Immediately it enters the leaf by making a small hole through the lower epidermis, against which the egg was lying. Some writers state that the larvae often wander a short distance before entering the leaf, but the writer has never found this to be the case. Once within the leaf the larva begins feeding rapidly. It is decidedly active, and the mouth hooks seldom cease their rapid motion except for short periods of rest. Two types of movements have been described for the mouth hooks of the larvae of *P. calyptrata* (page 103), a lateral and a ventral movement. As the larvae of *P. hyoscyami* feed in the same manner, the movements

TABLE 18. NUMBER OF EGGS LAID BY PEGOMYIA HYOSCYAMI

Experiment no.	July																													August																			Total number of eggs laid
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
D-55	S							1	6	F																																									7
D-54		S						12	39	19	F																																								70
D-48			S							8	F																																							8
C-12				S	S															6	F																													6
C-16					S										4			24				2	5								F																		35
C-15											S										6	5	12																1	F										24
D-10																S							7	9									F																	16
D-12																	S								13	2								F																15
E-9																	S															10	5	3	3														21
C-13																							S									2	6	F															8
D-11																											S								49			2				13	2				F		66

S, Experiment started. (A pair of flies placed in cage.)
F, Experiment finished. (Female died.)
D, Flies reared from *Beta vulgaris*.
C, Flies reared from *Spinacia oleracea*.
E, Flies reared from *Chenopodium album*.

of the mouth hooks are not described here. The larva removes the parenchyma not merely to liberate the plant juices; it actually takes the plant cells into its body. The alimentary canal is almost constantly in motion, and the juices of the plant, as well as groups of plant cells, can be seen traveling toward the posterior end of the larva's body. The movement of the alimentary canal appears as a series of peristaltic waves originating at the anterior end of the body. This wave-like motion is due to a series of constrictions which travel the length of the alimentary canal, thus forcing the food along. Occasionally this motion ceases for an instant and a pellet of frass is forced from the posterior end. Goureau (1851) states that the larvae seem to have continuous diarrhea, and any one who has observed them in their mines will be impressed with this statement.

A few notes were taken on the manner in which a larva starts a new mine on a fresh leaf. When a larva was placed on a fresh leaf it wandered about aimlessly for a few minutes, and then settled down and began making its way into the leaf. At first it made a semicircular slit on the under side of the leaf, by means of lateral strokes of the mouth hooks; then, by pushing the anterior end of its body into this slit and working it back and forth, it formed a small cavity, and this it rapidly enlarged until the whole body was drawn into the leaf. The operation was completed in fifteen minutes. Cameron (1914) made some observations on this point, and he found that the third-instar larva worked its way completely into the leaf in twenty-five minutes. He mentions also that a second-instar larva succeeded in working its way into the leaf in two hours and twenty minutes. He was unable to induce the first-instar larva to enter a fresh leaf.

The mines produced by this species present some details that are worth mentioning. When the eggs hatch, all the larvae from a single group of eggs enter the leaf by separate holes. Almost immediately after the larvae have entered the leaf, the channels made by them coalesce to form a single mine. Thus the larvae feed side by side, progressing only in a forward direction and producing as a result a linear mine. This linear mine is usually very short, seldom exceeding an eighth or a quarter of an inch in length except on the leaves of *Amaranthus retroflexus*, where it frequently becomes an inch or more long. In approximately a day the larvae separate, moving in different directions but remaining in the same common mine which they thus change to a blotch. When the mines are fresh they are greenish in color and the contents are moist; often after a hard rain they are partly filled with water. The frass is soft and green, and is scattered about the mine in small pellets. Later the mines become dry and parchment-like, and the frass becomes dried and pressed

against the upper and lower surfaces. On *Beta vulgaris* and *Chenopodium album* the mines become brownish when dry, but on *Amaranthus retroflexus* they become whitish. The pharyngeal skeletons, the mouth hooks, and sometimes even the cast larval skins, can be seen within the mines. The visibility of the mine from the upper or the lower surface of the leaves depends, to some extent, on the species of plant attacked. On plants with thick leaves, such as beets and spinach, the mine alternates from the lower to the upper surface and is seldom visible from both surfaces at the same time, except toward its completion. On the plants with thinner leaves, as *Chenopodium album* and *Amaranthus retroflexus*, the mine occupies the space between the upper and the lower epidermis, so that it is visible from both sides of the leaf.

The mines never attain any great size, for the larvae have the habit of abandoning their mines and forming new ones in fresh leaves. This is particularly true of larvae mining the leaves of Chenopodium, because these leaves are small and do not furnish enough food for the larvae's development. To illustrate this point the writer isolated a single *Chenopodium album* plant bearing sixteen leaves. On one of these leaves there had been deposited seven eggs. The remainder of the leaves were free from eggs or larvae. In two days the eggs hatched and all seven larvae entered the leaf on which they had been laid. On the following day the majority of the larvae, having become crowded, migrated to the other leaves. By the time the larvae had matured, all but two of the leaves of this plant had been destroyed.

The duration of the larval stage in this species is shown in table 19, and the duration of the respective instars is shown in table 20.

TABLE 19. LENGTH OF LARVAL PERIOD IN PEGOMYIA HYOSCYAMI

Experiment no.	Number of eggs laid	Date when eggs hatched	Date when puparium formed	Length of larval period (days)
E-25	2	June 6	June 22	16
E-38	3	10	24–25	14–15
D-30	3	10	25	15
E-36	4	10	22–25	12–15
E-33	5	10	21–24	11–14
E-34	2	11	28	17
E-44	8	14	25–29	11–15
E-43	4	15	26	11
D-112	1	Sept. 4	Sept. 13	9
D-107	2	4	14	10
D-119	3	5	14	9
D-125	1	9	19	10
D-121	2	9	19	10
D-118	1	10	22	12
E-84	1	15	24	9
C-28	1	15	26	11
D-105	2	5	14	9
C-30	1	15	28	13
C-31	3	16	28	12
C-32	3	17	28	11
E-88	3	23	Oct. 5	12
E-89	3	23	5–6	12–13
E-90	3	23	5–6	12–13
E-87	3	25	6	11
E-86b	2	25	7–8	12–13
E-86	3	25	9	14
C-33	3	Oct. 2	11	9
E-99	1	3	13	10
E-100	1	3	13	10
E-96	1	3	13	10
E-97	1	3	14	11
E-98	1	3	15	12
E-93	3	3	15	12
E-94	3	3	16	13
E-95	1	3	17	14
E-92	3	3	13	10
D-127	3	9	21	12

TABLE 20. DURATION OF LARVAL INSTARS IN PEGOMYIA HYOSCYAMI

First instar			Second instar		Third instar	
Date when eggs hatched	Date of first molt	Length of first instar (days)	Date of second molt	Length of second instar (days)	Puparium formed	Length of third instar (days)
Sept. 4	Sept. 6	2	Sept. 8	2	Sept. 14	6
5	7	2	.....	.....	14	.....
9	14	5	.....	.....	19	.....
9	12	3	.....	.....	.....	.....
10	14	4	.....	.....	Sept. 22	.....
11	15	4	Sept. 18	3	24	6
15	.....	.....	22	.....	28	6
15	Sept. 19	4	22	3	28	6
15	18	3	22	4	26	4
15	18	3	.....	.....	.....	.....
16	19	3	.....	.....	Sept. 28	.....
17	21	4	Sept. 24	3	28	4
23	27	4	29	2	Oct. 5	6
23	25	2	28	3	5	7
23	26	3	.....	.....	5	.....
25	28	3	Oct. 1	3	9	8
25	.....	.....	2	.....	7	5
25	Sept. 28	3	1	3	6	5
Oct. 1	Oct. 4	3	6	2	11	5
2	5	3	8	3	15	7
2	5	3	9	4	17	8
2	5	3	9	4	14	5
2	5	3	.....	.....	15	.....
2	.....	.....	Oct. 8	.....	13	5
3	.....	.....	8	.....	13	5
4	Oct. 6	2	9	3	16	7
.....	7	.....	11	4	17	6
Oct. 9	12	3	16	4	21	5
.....	.....	.....	9	.....	16	7

The puparium.— The full-grown larva, except in rare cases, breaks through the mine and falls to the ground. Occasionally a puparium has been found in the mine. Many of the larvae seek shelter under dried leaves or other rubbish to transform, others penetrate the ground and form their puparia at various distances below the surface. The writer has no original data, but cites the following as to the depth to which the larvae penetrate: Smith and Dickerson (1912), working with 487 larvae, found that some transformed under decayed material or dried leaves, and the remainder at various depths, from one-half to three inches, below the soil surface; Chevrel (1892)

states that he found some larvae at 2 centimeters (about 13/16 inch) below the surface, but the majority were at a depth of from 4 centimeters (about 1⅝ inches) to 5 centimeters (about 1 15/16 inches).

As a puparium, the insect remains in the ground or beneath rubbish for from eleven to twenty-seven days. In early spring the period is rather long; toward the middle of the summer it becomes shorter,

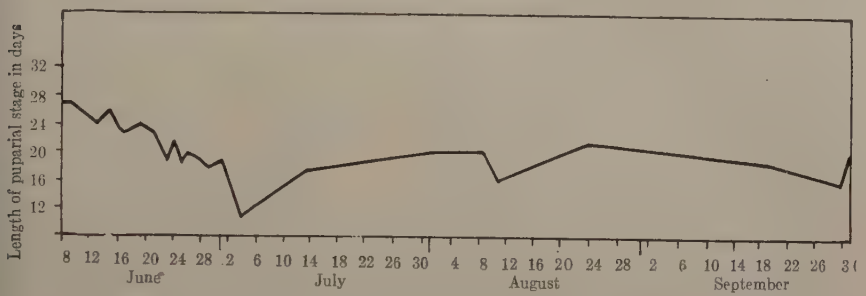

FIGURE 1. LENGTH OF PUPARIAL STAGE IN PEGOMYIA HYOSCYAMI AT VARIOUS TIMES DURING THE SUMMER

but it lengthens again as fall approaches (figure 1). Some individuals of each generation winter over as puparia and the adults issue in the following spring, thus making the pupal stage in some instances at least 320 days long. In the writer's work, individuals kept indoors over winter issued during February and March.

Flies from puparia buried several inches below the surface of the ground had no difficulty in making their exit and reaching the surface. A few experiments were performed by placing puparia in jelly tumblers at different depths in loosely compacted soil. Adults from puparia buried three inches in loose soil succeeded in making their escape. Decaux (1890) mentions that flies from puparia buried 20 centimeters in loose soil readily made their escape.

The adult.— The adult flies are interesting but are difficult to work with in captivity, especially in small cages. The majority of the experiments with the adults were carried on in wire cages 7½ by 4½ inches in size, made after the pattern of the Fiske cage. In some cases glass cylinders or lantern globes were used. The adults fed readily on sugar solution sprayed on leaves which were placed in these cages. In the field they were observed feeding on the surface of the leaves. On warm days, especially when the sun was shining, the flies were seen in large numbers running about the surface of the leaves, lapping up sweet juices from plant lice and other sources. On cool or rainy days they were very inactive, and were seen only at the

base of the plant or on the ground. No data are available on the length of life of the adults under natural conditions. The length of life of the adults confined in cages is shown in table 21:

TABLE 21. LENGTH OF LIFE OF ADULTS OF PEGOMYIA HYOSCYAMI

Experiment no.	Date of issuing	Date of death	Length of life (days)
Males:			
E-22	May 22	May 26	4
E-23	22	June 4	13
D-50	July 6	July 12	6
D-51	6	13	7
D-49	6	17	11
D-58	6	12	6
D-56	7	16	9
D-60	8	14	6
D-61	8	14	6
D-65	10	17	7
D-16	10	19	9
D-19	20	30	10
D-10	21	Aug. 5	15
E- 9	22	18	27
E-10	23	3	11
D-14	25	5	11
Females:			
E-24	May 22	June 14	23
E-22	22	6	15
E-23	22	8	17
D-58	July 6	July 14	8
D-16	10	Aug. 7	28
D-14a	12	July 24	12
D-83	15	22	7
C-15	16	Aug. 12	27
D-77	17	July 23	6
D-13	18	Aug. 9	22
D-12	22	9	18
D-14b	23	5	13
E-11	23	7	15
E-12	23	1	9
E-13	23	2	10
D-11	Aug. 1	23	22

Nothing has been published in American or European literature regarding the period elapsing between the time when the females issue and the time when the first eggs are laid. The writer found it hard to get data on this phase of the life history, because of the difficulty of rearing flies in confinement. In a long series of experiments, how-

ever, a few records were obtained which throw some light on the preoviposition period. In eleven instances the writer succeeded in inducing the females to lay eggs in captivity. In table 22 it is shown that from seven to sixteen days elapse between the time when the females issue and the time when the first eggs are laid.

TABLE 22. LENGTH OF PREOVIPOSITION PERIOD IN PEGOMYIA HYOSCYAMI

Date of emergence of female	Date when first eggs were laid	Length of preoviposition period (days)
July 6	July 13	7
7	12	5
8	15	7
10	25	15
10	21	11
16	26	10
21	28	7
22	30	8
22	Aug. 7	16
28	7	10
Aug. 1	10	9
Average number of days		9.55

Further information was obtained by the dissection of females at stated periods after emergence. Several females were dissected on the day when they issued, and the egg tubes were found to be undeveloped. Other females were dissected three days after issuing, and the terminal egg in each egg tube was found about half developed. Still other females were dissected at the end of eight days, and the terminal eggs were found fully developed; about sixty ovarioles were found in these dissected females, each ovariole containing at the time one ripe egg. Another female dissected at the end of thirteen days contained eggs ready to be laid. These notes indicate rather clearly that a period of at least seven or eight days elapses between the time when the female issues and the time when oviposition begins. Temperature conditions, as well as the promptness of the female to copulate after emerging, undoubtedly influence the length of the preoviposition period.

In getting the data for table 23 the females and the males were placed in two-dram vials upon emerging and in several cases copulation was observed. Small vials were used because copulation seemed

TABLE 23. Lapse of Time between Emergence of the Female and Copulation

Experiment no.	Date of emergence of female	Date of first copulation	Number of days	Date of second copulation	Number of days
D-57	July 6	July 11	5	.....	.....
C-12*	10	13	3	July 17	7
C-16*	10	10	0	.....	.....
C-13½*	11	15	4	.....	.....
C-14	12	15	3	July 16	4

* These females oviposited, the others did not.

to take place more readily than in larger vials. The adults were then transferred to Fiske cages, and daily records were made of the number of eggs laid. Sixty-seven pairs of flies were placed in the cages, but only eleven of the females laid eggs.

Copulation was observed several times. Cameron (1916–17) describes the operation and figures the adults in the act of copulation. He states that the flies remain in copulation for half an hour or longer. In two instances the writer watched through the entire duration, which lasted, in one case, an hour and fifty minutes, and in the second case an hour and twelve minutes.

Number of generations.— Records of the number of generations, as found in the literature of the subject, vary from one to seven for a single season. Decaux (1890) states that there is but one generation and that the flies pass the winter as puparia. On the other hand, Sirrine (1896) gives from six to seven generations for New York State. There is no doubt that several generations exist. These overlap one another, making it difficult to follow them throughout the summer. The writer has come to the conclusion that in a normal year there are at least four generations. He succeeded in following three of these very closely, as follows: the first generation, from May 14 to July 5 (52 days); the second generation, from July 6 to August 22 (47 days); the third generation, from August 23 to October 5 (43 days). Complications prevented following the generations any further, but, since eggs were noted in the field as late as November 13, there would still remain a period of 49 days for the fourth generation. Four generations were calculated theoretically in the following manner: The active period of the species during 1916 was approximately 188 days, beginning on May 14 and lasting until November 13. The average length of a complete generation was estimated to cover 45 days, including 8 days for the pre-

oviposition period, 5 days for the incubation period, 12 days for the larval period, and 20 days for the pupal period. According to these

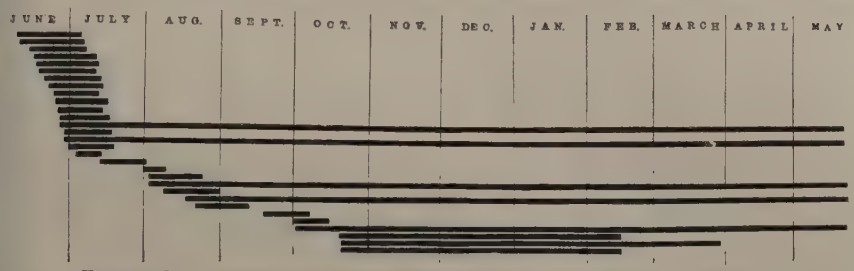

FIGURE 2. OVERLAPPING OF PUPARIAL STAGE IN PEGOMYIA HYOSCYAMI

Each black line, except the four longest ones, represents the average of the length of the puparial stage of ten individuals or more. The four longest lines show individual records. The diagram shows the overlapping of the puparial stages during the summer; the breaks in the diagram result from lack of data rather than divisions between generations

The diagram shows also the variation in the length of the puparial stage throughout the summer. In June the lines are long; toward the end of June and the beginning of July they become shorter; during August and September they are short except for a few individuals whose puparial stage lasts until the following spring

The lowest three lines are records of puparia that were kept indoors during the winter, as a result of which the adults issued earlier than normally

figures, only four generations would be possible during a normal season.

Seasonal life history and abundance.— In 1915 the adults of *P. hyoscyami* began to emerge on May 22 in the vicinity of Ithaca, New York. This date was obtained from puparia which were collected about Ithaca and left out of doors over winter, under natural conditions. The first eggs were laid outside on June 10. In 1916 the season was slightly earlier than in 1915. The first adults issued on May 14, and the first eggs were laid on June 5.

The eggs and the larvae were very abundant throughout the summers of 1915 and 1916, but became less common toward fall. Eggs and larvae were found in the field as late as November 13. On November 18, larvae were found in the field, but they were few in number and not very active. It is doubtful whether they survived. Some of these larvae were taken into the laboratory, where they matured and formed their puparia.

Parasites and predacious enemies.— Several parasites have been reared and recorded from the eggs and larvae of *P. hyoscyami*. In Europe, *Opius nitidulator* Rees. seems to be the most common. Reh (1913) and Cameron (1914) mention this species. Decaux (1890) describes *Decatoma betae* as a parasite, and Goureau (1851) describes *Alysia picta* from this same leaf-miner. In America four species have been recorded as parasites on the larvae. Among these are three spe-

cies of Opius, of which two—*Opius anthomyiae* Ashm. and *Opius foveolatus* Ashm.—have been recorded before, and the third is a new species which the writer reared. Smith and Dickerson (1912) mention a new species of Apanteles, *A. trachynotus* Vier., reared from *P. hyoscyami*. In addition the writer reared specimens of *Trichogramma minutum* Riley from the eggs.

The species of Opius are all parasitic on the larvae, attacking them while they are in their mines. The parasites transform within the puparia of the flies and issue considerably later than the flies themselves would have issued. No attempt was made to obtain separate data for the various species, but it was discovered that parasites issued from 28 to 41 days after the puparia were formed. The writer found the proportion of parasitized puparia, based on 100 larvae collected during the course of the summer, to be as high as 21 per cent.

Nabis ferus is a predacious species which attacks the larva of *P. hyoscami*.

Descriptions of stages

Eggs.—Length 0.85 to 0.9 mm. Pure white, elongate, rounded at one end, truncate at the other, delicately marked by a beautiful reticulated surface. Reticulation composed of irregular hexagonal depressions bounded by low ridges. Micropyle appearing at truncate end as a minute blackish spot.

First-instar larva.—Length on hatching, 1.75 mm. Body transparent, smooth, and shiny. Trachea, alimentary canal, and pharyngeal skeleton, plainly visible through integument. Rows of minute fleshy spines marking edges of many of the body segments, on lateral and ventral sides especially. Pharyngeal skeleton slender and weakly chitinized. Mouth hooks quadrangular in form, and bearing three well-defined teeth. Anterior spiracles not opening to exterior. Posterior end of larva rounded and not tuberculate. Posterior spiracles minute and with two curved breathing pores. Ends of trachea weakly chitinized but distinctly visible.

Second-instar larva.—Length immediately after first molt, about 2 mm.; before second molt, about 4 mm. Segmentation but little more pronounced than in first instar. Margins of segments and intersegmental areas marked by discontinuous rows of minute fleshy locomotory spines, these being more numerous and larger than in preceding instar. "Pseudo-cephalon" (Henneguy) bearing, in front of mouth hooks, a pair of sensory papillae, and in front of these a pair of two-segmented antennae. Sensory papillae not so closely approximated as antennae. On each side of mouth hooks, from eight to ten small, button-like areas. Mouth hooks subtriangular, with the upper basal angle prolonged, and bearing three teeth. Anterior spiracles fan-shaped, divided into from seven to nine lobes. Spiracles, and ends of trachea, weakly chitinized. Posterior aspect of last segment having four pairs of tubercles arranged about posterior spiracles. Spiracles borne on short pedicels and having two U-shaped breathing pores.

Third-instar larva.—Length 8 to 9 mm. Color creamy white. Body filled with an abundance of fat, this fat on dissection found to be arranged in sheets composed of large fat cells, one cell in thickness. Toward posterior third of body, alimentary canal and trachea visible between the sheets of fat. Segmentation much more pronounced than in preceding instar. Certain areas bearing rows of minute fleshy locomotory spines; on "pseudo-cephalon" and first two segments, these spines inconspicuous; ventrally and laterally, the spines conspicuous from third to last segment; dorsally, the spines becoming indistinct toward pos-

terior end of larva. As in preceding instar, "pseudo-cephalon" bearing a pair of two-segmented antennae and a pair of sensory papillae. Mouth hooks subtriangular, and bearing from four to six teeth, the number varying considerably but there being at least four well-defined teeth, some of which may be subdivided into smaller ones. Anterior spiracles fan-shaped, with from seven to ten lobes, the number of lobes varying considerably in different larvae and frequently differing on opposite sides of the same larva. Anus opening on ventral side of last segment, between two prominent lobes. Dorsal aspect of posterior segment bearing six pairs of tubercles, five of these pairs being arranged more or less in a circle about the posterior spiracles, and the sixth pair being ventrad of the posterior spiracles. Spiracles with three circular breathing pores.

Puparium.— Length 4.5 to 5 mm.; width 1.75 to 2 mm. Body cream- or straw-colored when first formed, but soon turning dark brown. Body slightly transparent, the mouth hooks frequently being seen pressed against inner wall. Segments marked with alternate shiny and dull areas; the shiny areas, under the microscope, marked by minute annular ridges which correspond to the transverse rows on the fleshy spines of the larva. Puparium tapering rather suddenly toward anterior end, which is cut off squarely. Posterior end rounded and showing little indication of the posterior tubercles of the larva. Anal opening appearing as a conspicuous groove. Posterior spiracles projecting very slightly.

Pegomyia ruficeps Stein (*nec* Meig.)

Pegomyia ruficeps Stein

Pegomyia ruficeps has been reported by Chittenden (1911) as a pest on sugar beets. Whether it is a leaf-mining species is unknown. It is a North American form and is included in Malloch's recent synopsis of North American species of Pegomyia (1920 b).

Pegomyia vanduzeei Mall.

1920 *Pegomyia vanduzeei* Mall.

Pegomyia vanduzeei is a recent species which was at first misidentified (Frost, 1919) as *P. affinis* Stein. *P. affinis* is a distinct species, however, and inhabits the nests of gophers; while *P. vanduzeei* is a leaf-miner.

Little or nothing is known about the distribution of *P. vanduzeei*. The writer has reared and collected specimens at Ithaca and Florida, New York, and at Arendtsville, Pennsylvania. The species mines exclusively on *Rumex* species. Adults have been reared by the writer from *R. crispus* and *R. obtusifolius*, and it is possible that other species of Rumex may be attacked.

The eggs of this species are pure white, and are much more beautiful than those of *Pegomyia calyptrata*. They are laid in neat transverse rows of from three to five, rarely six or seven, on the under surface of the leaf. They have never been found as abundant as in the preceding species, and never more than three or four groups have been found on a single leaf.

The tendency of individuals of the first generation to overwinter as puparia is shown in table 24:

TABLE 24. LENGTH OF PUPARIAL STAGE IN PEGOMYIA VANDUZEEI

Experiment no.	Number of puparia	Date when puparia formed	Date when adults issued	Number of adults	Length of puparial stage (days)
A-13	4	June 9	July 3	1	24
A-11	2	9	May 6*	2	332
A-10	2	9	July 3	1	24
A-12	9	11	May 16*	1	340
A-16	4	24	May 6*	3	317
A-19	4	July 1	May 6*	3	310

* Overwintered as puparia and issued in the following spring.

Descriptions of stages

Egg.— Length 1 mm.; width 0.35 mm. Pure white, waxy, and elongate. Surface delicately reticulated, the reticulation consisting of rectangular areas arranged in parallel longitudinal rows, producing a very regular and beautiful appearance. Micropyle end slightly flattened, opposite end rounded.

First-instar larva.— Length about 1 mm. Color translucent white. Trachea and alimentary canal visible through integument for entire length of body. Body decidedly smooth, with the exception of intersegmental areas and posterior aspect of last segment, which are covered with many transverse rows of fleshy locomotory spines. Anterior to mouth opening, a pair of sensory papillae. Tubercles on posterior aspect of last segment not distinct. Posterior spiracles borne on short stalks and having single breathing pores.

Second-instar larva.— Trachea and alimentary canal at first visible through integument, but soon becoming obscured by the accumulation of fat. Whole body minutely roughened, especially on intersegmental areas and edges of segments, this roughening caused by transverse rows of minute fleshy locomotory spines, as described for the first-instar larva. Pharyngeal skeleton strongly chitinized. Mandibular sclerites bearing two well-defined teeth and several smaller ones. Anterior to mouth opening, a pair of two-jointed antennae, and in front of these a pair of sensory papillae. On each side of "pseudo-cephalon," a row of minute button-like areas extending from mouth opening dorsad. Posterior spiracles with two breathing pores.

Third-instar larva.— Much resembling preceding stage, but dirty white in color. Locomotory spines on intersegmental areas more conspicuous than in preceding instar, being usually rendered visible to the naked eye by means of the dirt that catches between them. As in preceding stage, "pseudo-cephalon" bearing a pair of two-jointed antennae and a pair of sensory papillae in front of mouth cavity. Anterior spiracles consisting of oval, slightly chitinized disks, which are surrounded by about twenty-four breathing pores. On posterior aspect of last segment, six small tubercles surrounding spiracles ventrally in a semicircle. Posterior spiracles with three breathing pores.

Puparium.—White or slightly creamy in color when first formed, but in about two hours turning dark brown or almost black. Color turning grayish when puparium becomes dry. The two anal plates of the larva, which are visible in the puparium, surrounded by a depressed ring.

The characters of *P. calyptrata* and *P. vanduzeei* are compared in table 25:

TABLE 25. SUMMARY OF CHARACTERS OF PEGOMYIA CALYPTRATA AND P. VANDUZEEI

Characters	In *P. calyptrata*	In *P. vanduzeei*
Egg:		
Color	White, glossy	White, waxy
Shape	Pointed at one end	Rounded at both ends
Reticulations	Polygonal	Rectangular
Larva:		
Color	Yellow, shiny	Dirty white, dull
Mouth hooks	With 3 teeth	With 4 teeth
Sensory papillae	Close together, smaller than antennae	Not close together, about same size as antennae
Posterior end	Not tuberculate	Tuberculate
Puparium:		
Color	Brown	Black
Segmentation	More distinct	Less distinct
Adult:		
Color	Abdomen yellow, thorax bluish gray	Abdomen and thorax gray

Pegomyia winthemi Meig.

1826 *Anthomyia winthemi* Meig.
1839 *Sapromyza blepharipteroides* Duf.
1840 *Anthomyia scutellaris* Ros.
1846 *Anthomyia latitarsis* Zett.
1866 *Anthomyia digitaria* Rond.
1883 *Anthomyia transversa* Meade

Pegomyia winthemi has a northern distribution in the United States. It has been collected at Ithaca, New York, and at Orono, Maine. It has been recorded from Montreal, Canada, from Europe, and from Africa. The life history of the species has never been worked out, although Winn and Beaulieu (1915) mention having reared it from *Rumex* species.

European leaf-mining species of Pegomyia

There are several European species of Pegomyia which have been recorded as leaf-miners. These are listed as follows: *P. hystrix* Brischke, *P. incana* Brischke, *P. grossa* Brischke, *P. milis* Macq., *P. nigritarsis* Zett., *P. sulcans* Rond., *P. polygoni* Kaltb., *P. versicolor* Meig. There is in this country a species which occurs commonly on *Polygonum persicaria* and which, although it has never been reared and determined, may prove to be the same as the European form *Pegomyia polygoni* Kaltb.

UNDETERMINED SPECIES OF DIPTEROUS LEAF-MINERS, ARRANGED ACCORDING TO HOSTS

Populus deltoides (Poplar).— Many leaf-mining insects have been found on poplar. Among these are several species of Lepidoptera, a species of Coleoptera, and, the one of the most interest to the writer, a species of Agromyzidae. This fly produces a broad linear mine, whitish in color, on the under surface of the leaf. Often the mine curves upon itself, tending to form a blotch. The frass is inconspicuous and scattered about the mine. When the larva is full-grown it abandons the leaf to transform. The mine resembles somewhat that of *Nepticula populetorum*, although the latter has a prominent frass line. It resembles also that of the coleopterous miner of poplar, but is not nearly so large and never quite so blotch-like.

Salix nigra (Willow).—A dipterous miner has been found on the willow at Ithaca, New York, but it was never reared nor determined. The mine is a blotch and the larva transforms within it.

Cornus amomum and *C. circinata* (Dogwood).— The writer has frequently seen a rather long linear mine on these two species of dogwood. The mine is greenish in the center and whitish along the sides, and has a wavy band of frass down the center.

Crataegus species (Hawthorn).—A single mine containing a dipterous larva was found on a hawthorn plant. The mine was serpentine and had a faint frass line in the center.

Smilacina racemosa (False Solomon's seal).— The writer has often taken dipterous miners from the leaves of the false Solomon's seal. The conspicuous white eggs are found on the lower side of the leaves. When the larvae hatch, they mine between the parallel veins of the leaf, making a rather broad linear mine which is plainly visible from both surfaces. When full-grown, the larva makes its exit through a slit at the edge of the mine, and transforms outside the leaf. The puparium is noticeably elongate and is brownish in color. The larvae have been found only during the early part of the summer; on June 24, at Ithaca, New York, they were found in abundance. Puparia were formed from June 30 to July 6. No adults issued, but parasites emerged on July 17.

Polygonatum commutatum (Solomon's seal).— The miner found on the true Solomon's seal may be the same as that found on the false Solomon's seal. The eggs are similar, but are laid on the upper surface of the leaf. The mines are usually narrower.

Other host plants.— In addition to the above-named plants, linear leaf-miners among the Diptera have been found on *Arctium lappa*, *Clematis virginiana*, *Mitella diphylla*, *Aralia nudicaulis*, *Rubus alleghenicnsis*, *Althaea rosea*, *Heliopsis helianthoides*, and *Elymus virginicus*. Blotch miners have been found on *Rudbeckia laciniata*, *Stellaria media*, *Hydrophyllum canadense*, *Prenanthes trifoliolata*, and *Calendula officinalis*. Still other species of leaf-miners have been found on *Cicuta maculata*, *Lycopersicon lycopersicum*, and *Polygonatum biflorum*.

[*Phytomyza nitida* Mel.]

(Description omitted from page 80)

Adult.— Small, length 1.3 mm., color black. Front, face, cheeks, antennae, and palpi, black, proboscis yellow or pale. Front scarcely as wide as either eye, slightly longer than wide; frontal stripe opaque; orbits shiny black; three pairs of fronto-orbital bristles; a row of inconspicuous setae on margin or orbit adjacent to eye margin; a row of conspicuous small setae on hind outer margin of back of head, extending down the edge of the cheek; cheeks narrow, about one-fourth eye height. Third antennal joint medium-sized, rounded; arista about twice as long as third antennal segment, nearly bare. Mesonotum and scutellum subshiny black; four pairs of dorso-central bristles; two or three irregular rows of minute acrostichals, extending only halfway to scutellum. Legs black. Abdomen shiny black. Wings hyaline; second and third sections of costa as 1:1½; vein 4 nearly straight, not curving into costa; vein 5 ending more than halfway from base to apex of wing; calypteres with dusky margin and fringe.

Described from seven specimens reared by the writer from *Nepeta cataria*. Compared with paratype loaned by Dr. A. L. Melander, also compared with two specimens in the Hendel collection.

PARASITIC AND PREDACIOUS ENEMIES OF DIPTEROUS LEAF-MINERS

The leaf-mining Diptera are attacked by many parasitic and predacious enemies. The former are by far the more numerous and consist entirely of Hymenoptera; the latter are few in number and include Hemiptera and Acarina.

It is striking to note the large number of parasitic Hymenoptera that attack the relatively small number of leaf-mining Diptera. Thirty-two parasitic genera and about eighty species have been reared by the writer or recorded by other investigators. There are also many new species that have been reared but never described. Twenty-six of the known species of parasites have been recorded from North America. On the other hand, only sixty-three dipterous leaf-miners have been recorded from this continent. The following is a list of the genera parasitic on dipterous leaf-miners:

HYMENOPTEROUS GENERA PARASITIC ON DIPTEROUS LEAF-MINERS

Braconidae:
- Opius Wesm.
- Sigalphus Latr.
- Neopius Gahan

Alysiidae:
- Adelura Först.
- Alysia Latr.
- Aspilota Först.
- Symphya Först.
- Dacnusa Hal.

Cynipidae:
- Eucoila Westw.

Ichneumonidae:
- Hemiteles Grav.
- Stilpnus Grav.

Chalcidoidea:
- Sympiesis Först.
- Pleurotropis (Först.) Ashm.
- Entedon Dalm.
- Syntomosphyrum Först.
- Notanisomorpha Ashm.
- Cirrospilus Westw.
- Diaulinopsis Cwfd.
- Pachylarthrus Westw.
- Macroglenes Westw.
- Pteromalus Swed.
- Polycystus Westw.
- Chrysocharis (Först.) Westw.
- Closterocerus Westw.
- Derostenus Westw.
- Diaulinus Scholtz
- Trichogramma Westw.
- Solenopsis Westw.
- Achrysocharis Girault
- Brachymeria Westw. (Chalcis [of authors])
- Zagrammosoma Ashm.
- Decatoma Spin.

The subfamily Opiinae, according to Gahan (1916), has been recorded as parasitic on Diptera, Coleoptera, and Lepidoptera. This subfamily includes the majority of the parasites of the leaf-mining Diptera. Their usual hosts appear to be the phytophagous Diptera belonging to the Agromyzidae and the Anthomyiidae. The species of the parasitic genus Opius are restricted to the Diptera as hosts, and almost entirely to the leaf-mining forms. Two records have been found of Opius parasitic on species of Anastrepha (Trypetidae) which feed in fruits. Sigalphus, unlike Opius, is not so limited in its selection of hosts. Various species of this genus have been reared from *Conotrachelus* species (Coleoptera), *Copturus* species (Coleoptera), and *Andricus* species (Hymenoptera).

Some of the Chalcidoidea occur as parasites on leaf-miners, while many have been reared from lepidopterous pupae, some from eggs of Lepidoptera and Orthoptera, some from tachinid and hymenopterous parasites, some from scale insects, and a few from Coleoptera. It is very noticeable that many of the genera Chrysocharis, Closterocerus, Derostenus, Diaulinus, Diaulinopsis, Notanisomorpha, and Pleurotropis, have been reared from species of Agromyzidae which mine leaves.

The predacious forms are few in number. Webster and Parks (1913) record a species of mite, of the genus Erythraeus, which attacks the larvae of *Agromyza pusilla* Meig. in the mines. He found also a Hemiptera, *Thriphleps* sp., attacking the same leaf-miner. The writer found *Nabis ferus* attacking the larvae of *Pegomyia calyptrata* Zett. Other workers have found this species attacking the beet leaf-miner, *Pegomyia hyoscyami* Panz. Still another form, *Chrysopa rufilabris* Burm., is predacious on *Agromyza platyptera* var. *jucunda* V. d. W.

A LIST OF HYMENOPTERA PARASITIC ON DIPTEROUS LEAF-MINERS

(Arranged according to hosts)

Acidia heraclei Linn.

Alysia apii Curtis
Alysia tipulae Perris
Aspilota fuscicornis Haliday
Hemiteles crassicornis Grav.
Pachylarthrus smaragdinis Haliday
Sigalphus flavipalpis Wesm.
Syntomosphyrum species

Spilographa zoe Loew

Brachymeria species

Agromyza angulata Loew

Dacnusa agromyzae Gahan
Derostenus agromyzae Cwfd.
Derostenus diastatae How.
Entedon thomsoni Cwfd.
Notanisomorpha ainsliei Cwfd.
Pleurotropis rugosithorax Cwfd.
Polycystus foersteri Cwfd.

Agromyza borealis Mall.

Chrysocharis species (writer)

Agromyza coquilletti Mall.

Derostenus pictipes Cwfd.

Agromyza felti Mall.

Chrysocharis mallochi Gahan

Agromyza inaequalis Mall.

Diaulinus insularis Gahan

Agromyza laterella Zett.

Dacnusa iridicola Gahan

Agromyza melampyga Loew

Sympiesis felti Cwfd.

Agromyza parvicornis Loew

Chrysocharis ainsliei Cwfd.
Chrysocharis parksi Cwfd.
Cirrospilus flavoviridis Cwfd.
Closterocerus tricinctus Ashm.
Closterocerus utahensis Cwfd.
Derostenus diastatae How.
Derostenus fullowayi Cwfd.
Derostenus punctiventris Cwfd.
Diaulinus begini Ashm.
Diaulinus pulchripes Cwfd. (writer)
Diaulinus websteri Cwfd.
Macroglenes species
Notanisomorpha ainsliei Cwfd.
Opius diastatae Ashm.
Opius otiosus Gahan
Opius succineus Gahan
Opius utahensis Gahan
Pleurotropis utahensis Cwfd.
Solenopsis geminata
Sympiesis agromyzae Gahan
Sympiesis species
Zagrammosoma multilineata Ashm.
Elachertinae (a species)

Agromyza platyptera var. **jucunda** V. d. W.

Diaulinopsis callichroma Cwfd.
Diaulinus websteri Cwfd.

Agromyza pruinosa Coq.

Symphya agromyzae Rohwer

Agromyza pusilla Meig.

Chrysocharis ainsliei Cwfd.
Chrysocharis parksi Cwfd.
Cirrospilus flavoviridis Cwfd.
Cirrospilus species
Closterocerus utahensis Cwfd.
Derostenus arizonensis Cwfd.
Derostenus diastatae How.
Derostenus fullowayi Cwfd.
Derostenus pictipes Cwfd.
Derostenus punctiventris Cwfd.
Derostenus varipes Cwfd.
Diaulinopsis callichroma Cwfd.
Diaulinopsis species
Diaulinus begini Ashm.
Diaulinus websteri Cwfd.
Eucoila hunteri Cwfd.
Opius agromyzae Vier.
Opius aridis Gahan
Opius brunceipes Gahan
Opius succineus Gahan
Opius suturalis Gahan
Pleurotropis rugosithorax Cwfd.
Pteromalus species (secondary)
Sympiesis species
Zagrammosoma multilineata Ashm.

Agromyza scutellata Fall.
Closterocerus species
Derostenus diastatae How.
Zagrammosoma multilineata Ashm.

Agromyza species
Achrysocharis camilli Girault (on host mining alfalfa)
Neopius carinanacticeps Gahan (on host mining Hordeum)
Opius dimidiata Ashm.
Opius succineus Gahan (on host mining Panicum)
Symphya agromyzae Rohwer

Cerodonta femoralis Meig.
Cirrospilus flavoviridis Cwfd.
Dacnusa species
Diaulinus websteri Cwfd.
Opius coriaceus Gahan

Phytomyza aquilegiae Hardy
Chrysocharis species
Closterocerus tricinctus Ashm.
Closterocerus utahensis Cwfd.
Derostenus pallipes Gahan
Derostenus pictipes Cwfd.
Derostenus varipes Cwfd.
Diaulinus begini Ashm.
Diaulinus pulchripes Cwfd.
Sympiesis agromyzae Gahan
Zagrammosoma multilineata Ashm.

Phytomyza chrysanthemi Kowarz
Chrysocharis species
Diaulinus intermedius Girault
Opius mandibularis Gahan

Phytomyza obscurella Fall.
Chrysocharis parksi Cwfd.

Phytomyza plantaginis R-D.
Opius oscinidis Ashm.

Scaptomyza adusta Loew
Chrysocharis species (writer)
Dacnusa scaptomyzae Gahan (writer)
Opius quebecensis Prov. (writer)

Scaptomyza flaveola Meig.
Dacnusa scaptomyzae Gahan

Anthomyia species
Stilpnus anthomyidiperda Vier.

Pegomyia bicolor Wied.
Brachymeria species
Opius anthomyiae Ashm.

Pegomyia calyptrata Zett.
Dacnusa scaptomyzae Gahan (writer)
Opius quebecensis Prov. (writer)
Trichogramma minutum Ril (writer)

Pegomyia hyoscyami Panz.
Alysia picta Goureau
Apanteles trachynotus Vier. (e roneous)
Brachymeria species
Decatoma betae Decaux
Opius anthomyiae Ashm.
Opius foveolatus Ashm. (writer)
Opius nitidulator Rees.
Opius pegomyiae Gahan
Opius n. sp. (writer)
Serphus (*Proctrotrypes*) speci (?)
Trichogramma minutum Ril (writer)

A LIST OF THE LEAF-MINING DIPTERA OF THE WORLD, AND THEIR HOST PLANTS

The following list was compiled after a thorough examination of the European and American literature of the subject. Many records have been added from collections and rearings by the writer, as well as from material furnished by numerous collectors to whom credit has already been given. The species of Diptera are arranged according to families, with their hosts and general distribution. The hosts from which the writer reared the species are indicated by an asterisk.

TIPULIDAE

Dicranomyia foliocuniculator Swezey

CYRTANDRACEAE

Cyrtandra paludosa — Hawaii

CECIDOMYIIDAE

Monarthropalpus buxi Lab.

BUXACEAE

Buxus sempervirens — North America, Europe

Thecodipolosis liriodendri O. S. (doubtful)

MAGNOLIACEAE

Liriodendron tulipifera — North America

MYCETOPHILIDAE

Sciara species (doubtful)

COMPOSITAE

Cirsium arvense — Denmark

GRAMINEAE

Phragmites communis — Europe

PHORIDAE

Phora rufipes Fall. (doubtful)

COMPOSITAE

Cirsium arvense — Denmark

GRAMINEAE

Phragmites communis — Europe

TRYPETIDAE

Acidia cognata Wied.

COMPOSITAE

Arctium species	Europe
Petasites species	Europe
Tussilago species	Europe

Acidia heraclei Linn.

COMPOSITAE

Arctium species	Europe
Artemisia vulgaris	Europe
Carduus species	Europe
Chrysanthemum species	Europe
Cirsium arvense	Europe
Cnicus arvensis	France
Helianthus tuberosus	Europe
Onopordum acanthium	Europe
Prenanthes canadense*	North America

POLYGONACEAE

Rumex aquaticus	Europe

UMBELLIFERAE

Angelica sylvestris	France
Apium graveolens	France
Cryptotaenia canadensis*	North America
Heracleum asperum	France
Heracleum giganteum	Germany
Heracleum lanatum	North America
Heracleum longifolium	France
Heracleum sphondylium	France
Levisticum officinale	Germany
Ligusticum species	Europe
Pastinaca sativa*	Europe, North America
Petroselinum petroselinum	Europe
Sium latifolium	Germany

Acidia lucida Fall.

COMPOSITAE

Arctium bardana	Europe
Arctium majus	Europe
Helianthus tuberosus	Europe
Petasites frigidus	Europe
Petasites neveus	Europe
Petasites officinalis	Europe
Tussilago farfara	Europe

Acidia tussilaginis Fabr.

COMPOSITAE

Tussilago farfara	Europe

Oxyna plantaginis Haliday

PLANTAGINACEAE

Plantago maritima	Europe

Spilographa artemisiae Fabr.

COMPOSITAE

Artemisia absinthium	Europe
Artemisia discolor	Europe
Artemisia dracunculus	Europe
Artemisia graphaloides	Europe
Artemisia selengensis	Europe
Artemisia vulgaris	Europe
Chrysanthemum lacustre	Europe
Chrysanthemum leucanthemum	Europe
Chrysanthemum parthenifolium	Europe
Chrysanthemum parthenium	Europe
Senecio vulgaris	Europe
Tanacetum vulgare	Europe

Spilographa zoe Loew

COMPOSITAE

Arctium majus	Europe
Arctium minus	Europe
Chrysanthemum leucanthemum	Europe
Chrysanthemum parthenium	Europe
Eupatorium cannabinum	Europe
Senecio aquatica	Europe
Senecio eurcifolius	Europe
Senecio vulgaris	Europe

AGROMYZIDAE

Agromyza abiens Zett.

BORAGINACEAE

Anchusa officinalis	Europe
Asperugo procumbens	Europe
Lycopsis arvensis	Europe

COMPOSITAE

Chrysanthemum inodorum	Europe

Agromyza albitarsis Meig.

BETULACEAE

Alnus glutinosa	Europe
Alnus incana	Europe
Betula verrucosa	Europe

SALICACEAE

Populus tremula	Europe

Agromyza allecta Melander

COMPOSITAE

Arctium lappa*	North America
Bidens frondosa*	North America
Eupatorium purpureum*	North America

Agromyza amoena Meig. (See also *A. pusilla* Meig.)

CAPRIFOLIACEAE

Sambucus nigra	Europe
Sambucus racemosa	Europe

Agromyza angulata Loew

CYPERACEAE

Cyperus acuminatus*	North America

GRAMINEAE

Hystrix patula	North America
Phleum pratense	North America
Setaria glauca	North America

Agromyza anthracina Meig.

LEGUMINOSAE

Cytisus scoparius	Denmark

URTICACEAE

Parietaria officinalis	Europe
Urtica dioica	Europe

Agromyza astragali

LEGUMINOSAE

Astragalus glycyphyllus	Europe

Agromyza atra Meig.

CYPERACEAE

Carex hirta	Europe

GRAMINEAE

Dactylis species	Europe
Festuca gigantea	Europe
Hordeum vulgare	Europe
Molinia coerulea	Europe
Secale brandypodium	Europe
Triticum repens	Europe

IRIDACEAE

Iris pseudacorus	Europe

UMBELLIFERAE

Pastinaca sativa	Europe

Agromyza atripes Brischke

COMPOSITAE

Artemisia vulgaris	Europe
Aster amellus	Europe

Agromyza bellidis Kaltb.

COMPOSITAE

Aster chinensis	Europe
Bellis perennis	Denmark

Agromyza bimaculata Meig.

JUNCACEAE

Luzula pilosa	Europe

Agromyza borealis Mall.

BALSAMINACEAE

Impatiens biflora*	North America
Impatiens pallida*	North America

Agromyza bryoniae Kaltb.

CUCURBITACEAE

Bryonia dioica	Europe

Agromyza carbonaria Zett.

COMPOSITAE

Cirsium arvense	Denmark
Cirsium palustre	Denmark

LEGUMINOSAE

Trifolium alpestre	Europe
Trifolium pratense	Denmark
Trifolium repens	Europe

ROSACEAE

Potentilla anserina	Denmark
Spiraea ulmaria	Europe

Agromyza citreifemorata Watt

MYOPORACEAE

Myoporum laetum	New Zealand

Agromyza clara Melander

BIGNONIACEAE

Catalpa bungei	North America

Agromyza clianthi Watt

LEGUMINOSAE

Clianthus puniceus	New Zealand

Agromyza coffeae de Meij. (*See Oscinis coffeae* de Meij., Oscinidae, page 170.)

Agromyza coniceps Mall.

COMPOSITAE

Sonchus asper	North America

Agromyza coquilletti Mall.

GRAMINEAE

Avena sativa	North America
Elymus canadensis	North America
Hordeum jubatum	North America
Triticum sativum	North America
Triticum vulgare	North America
Zea mays	North America

Agromyza curvipalpis Zett.

COMPOSITAE

Aster amellus	Europe
Solidago virgaurea	Europe

Agromyza curvipalpis var. *texana* Mall.

COMPOSITAE

Ambrosia artemisiifolia*	North America
Aster arvensis*	North America
Aster divaricatus*	North America
Aster novae-angliae*	North America
Aster paniculatus*	North America
Aster undulatus*	North America
Eupatorium urticaefolium*	North America
Solidago bicolor*	North America
Solidago caesia*	North America
Solidago canadensis*	North America
Solidago juncea*	North America
Solidago latifolia*	North America
Solidago serotina*	North America

CRUCIFERAE

Roripa species	North America

LABIATAE

Nepeta cataria*	North America

Agromyza echii Kaltb.

BORAGINACEAE

Echium vulgare	Europe

Agromyza eupatoriae Mall.

COMPOSITAE

Eupatorium odoratum	North America

Agromyza fasciola Meig.

COMPOSITAE

Eupatorium cannabinum	Europe

VALERIANACEAE

Valeriana officinale	Europe

Agromyza felti Mall.

POLYPODIACEAE

Asplenium pinnatifidum	North America
Camptosorus rhizophyllus*	North America

Agromyza ferruginosa V. d. W.

BORAGINACEAE

Symphytum officinale	Europe

Agromyza flaviceps Fall.

URTICACEAE

Humulus lupulus	Europe

Agromyza flavifrons Meig.

CARYOPHYLLACEAE

Dianthus chinensis	Europe
Lychnis flos-cuculi	Europe
Lychnis molachium	Europe
Melandrium album	Europe
Melandrium rubrum	Europe
Saponaria officinalis	Europe
Silene pendula	Europe
Silene vulgaris	Europe
Stellaria aquatica	Europe
Stellaria media	Europe

Agromyza flavocentralis Watt

SCROPHULARIACEAE

Veronica salicifolia	New Zealand
Veronica speciosa	New Zealand

Agromyza flavolateralis Watt

VIOLACEAE

Melicytus ramiflorus	New Zealand

Agromyza flavopleura Watt

POLYPODIACEAE

Asplenium flaccidum	New Zealand
Lomaria filiformis	New Zealand
Polypodium australe	New Zealand
Polypodium billardieri	New Zealand

Agromyza flavopleura var. *casta* Watt

POLYPODIACEAE

Asplenium lucidum	New Zealand

Agromyza fragariae Mall.

ROSACEAE

Fragaria virginiana	North America
Rubus idaeus*	North America
Rubus odoratus*	North America
Rubus species (blackberry)*	North America
Rubus species (blackcap raspberry)*	North America

Agromyza frontalis Meig.

URTICACEAE

Humulus lupulus	Europe

Agromyza gei Brischke

ROSACEAE

Geum urbanum	Europe

Agromyza geniculata Fall.

CARYOPHYLLACEAE

Stellaria holostea	Europe

Agromyza gyrans Fall.

CAMPANULACEAE

Campanula trachelium — Europe

Agromyza heraclei Bouché

UMBELLIFERAE

Heracleum species — Europe

Agromyza hieracii Kaltb.

COMPOSITAE

Hieracium murorum — Europe

Agromyza hilarella Zett.

POLYPODIACEAE

Pteris aquilina — Europe

Agromyza holosericea Bouché

SCROPHULARIACEAE

Verbascum nigrum — Europe

Agromyza impatientis Brischke

BALSAMINACEAE

Impatiens noli-tangere — Europe
Impatiens parviflora — Europe

ONAGRACEAE

Circaea lutetiana — Europe

Agromyza inaequalis Mall.

LEGUMINOSAE

Phaseolus lunatus — North America
Vigna repens — North America

Agromyza incisa Meig.

GRAMINEAE

An undetermined species — Europe

Agromyza inconspicua Mall.

GRAMINEAE

Agropyron species — North America

Agromyza iraeos Dur.

IRIDACEAE

Iris foetissima — Europe
Iris gigantea — Europe
Iris pseudacorus — Europe

Agromyza lamii Kaltb.

LABIATAE

Ballota nigra — Europe
Lamium album — Europe
Lamium maculatum — Europe
Leonurus cardiaca — Europe

Agromyza laminata Brischke

GRAMINEAE

Phleum pratense	Europe
Phragmites communis	Europe
Triticum repens	Europe

IRIDACEAE

Iris pseudacorus	Europe

Agromyza lateralis Macq.

COMPOSITAE

Sonchus oleraceus	Europe

Agromyza laterella Zett.

IRIDACEAE

Iris versicolor*	North America

Agromyza lutea Meig.

BALSAMINACEAE

Impatiens noli-tangere	Europe

BORAGINACEAE

Symphytum officinale	Denmark

Agromyza macquarti Gour.

SCROPHULARIACEAE

Verbascum thapsus	France

Agromyza maculosa Mall.

COMPOSITAE

Arctium lappa	North America
Arctium minus	North America
Aster species	North America
Bidens leucantha	North America
Chrysanthemum indicum	North America
Helianthus annuus	North America
Xanthium canadense	North America

Agromyza marginalis Mall.

GRAMINEAE

Paspalum dilatatum	North America

Agromyza maura Meig.

COMPOSITAE

Solidago virgaurea	Europe

LABIATAE

Ballota nigra	Europe
Betonica palustris	Europe
Lamium album	Europe

RANUNCULACEAE

Delphinium staphisagria	Europe

Agromyza maura var. *nasuta* Melander

COMPOSITAE

Taraxacum officinale*	North America

Agromyza meijerei Hendel

LEGUMINOSAE	
Cytisus laburnum	Europe

Agromyza melampyga Loew

PLANTAGINACEAE	
Plantago major	North America
SAXIFRAGACEAE	
Philadelphus grandiflorus*	North America

Agromyza minuta Meig.

ROSACEAE	
Pyrus malus	Europe

Agromyza morio Brischke

RUBIACEAE	
Asperula odorata	Europe
Galium sylvaticum	Europe

Agromyza nana Meig.

IRIDACEAE	
Iris pseudacorus	Europe
LEGUMINOSAE	
Anthyllis vulneraria	Europe
Medicago falcata	Europe
Melilotus officinalis	Europe
Onobrychis vicaefolia	Europe
Trifolium arvense	Europe
Trifolium campestre	Europe
Trifolium incarnatum	Europe
Trifolium nana	Europe
Trifolium pratense	Europe
Trifolium repens	Europe

Agromyza neptis Loew (doubtful)

GRAMINEAE	
Zea mays	North America

Agromyza nigripennis Zett.

LEGUMINOSAE	
Medicago sativa	Europe

Agromyza nigripes Meig.

CARYOPHYLLACEAE	
Stellaria media	Europe
GRAMINEAE	
Hordeum murinum	Europe
Phragmites communis	Europe
LEGUMINOSAE	
Medicago sativa	Europe
Onobrychis sativa	Europe

Agromyza orbona Meig. (See also *A. pusilla* Meig.)

LEGUMINOSAE

Ononis repens	Europe
Ononis spinosa	Europe

Agromyza orobi Hendel

LEGUMINOSAE

Lathyrus vernus	Europe

Agromyza parvicornis Loew

GRAMINEAE

Echinochloa crusgalli	North America
Panicum commutatum*	North America
Panicum miliaceum	North America
Panicum sanguinale	North America
Phleum pratense*	North America
Triticum sativum*	North America
Zea mays	North America

Agromyza phragmitidis Hendel

GRAMINEAE

Phragmites communis	Europe

Agromyza plantaginis Haliday

PLANTAGINACEAE

Plantago maritima	Europe

Agromyza platyptera var. *coronata* Loew

COMPOSITAE

Aster novae-angliae*	North America
Solidago cæsia*	North America
Solidago canadensis*	North America
Solidago latifolia*	North America

VERBENACEAE

Verbena species*	North America

VIOLACEAE

Viola species*	North America

Agromyza platyptera var. *jucunda* V. d. W.

BORAGINACEAE

Cynoglossum officinale	North America

COMPOSITAE

Ambrosia artemisiifolia*	North America
Aplopappus squamosa	North America
Aster ericoides	North America
Cynara scolymus	North America
Erigeron species	North America
Helianthus annuus	North America
Rudbeckia laciniata var. flore-pleno	North America
Solidago altissima*	North America
Solidago californica	North America
Solidago canadensis*	North America
Solidago juncea*	North America
Xanthium strumarium	North America
Zinnia species	North America

CONVOLVULACEAE	
Ipomoea batatas	Cuba
LABIATAE	
Ocimum basilicum	Cuba
LEGUMINOSAE	
Phaseolus vulgaris	North America
MALVACEAE	
Abutilon theophrasti	North America
Althaea rosea	Cuba
Malva rotundifolia	North America
UMBELLIFERAE	
Heracleum lanatum*	North America
VERBENACEAE	
Verbena species	North America
Agromyza posticata Meig.	
BORAGINACEAE	
Lycopsis arvensis	North America, Europe
COMPOSITAE	
Aster amellus	Europe
Aster arvensis	North America
Aster laevis*	North America
Aster novae-angliae*	North America
Aster paniculatus*	North America
Aster undulatus*	North America
Solidago bicolor*	North America
Solidago caesia	North America
Solidago canadensis	North America
Solidago juncea	North America
Solidago latifolia	North America
Solidago nemoralis*	North America
Solidago serotina	Europe
Solidago virgaurea	Europe
GERANIACEAE	
Tropaeolum minus	Europe
HAMAMELIDACEAE	
Liquidambar styraciflua	North America
LEGUMINOSAE	
Medicago sativa	North America
LOBELIACEAE	
Lobelia cardinalis	North America
SOLANACEAE	
Solanum tuberosum	North America
VITACEAE	
Psedera quinquefolia	North America

Agromyza potentillae Kaltb.

ROSACEAE

Potentilla anserina	Europe

Agromyza pulicaria Meig.

COMPOSITAE

Solidago virgaurea	Europe

LABIATAE

Ballota nigra	Europe

LEGUMINOSAE

Cytisus scoparius	Europe

Agromyza pusilla Meig. (See also *A. amoena* Meig., *A. orbona* Meig., *A. strigata* Meig.)

AMARANTHACEAE

Amaranthus viridis	Cuba

ASCLEPIADACEAE

Asclepias incarnata*	North America
Asclepias syriaca*	North America
Asclepias tuberosa*	North America

CAPRIFOLIACEAE

Sambucus ebalus	Europe

CHENOPODIACEAE

Beta vulgaris*	North America
Spinacia oleracea*	North America

COMPOSITAE

Cichorium intybus*	North America
Eupatorium cannabinum	Europe
Eupatorium purpureum*	North America
Eupatorium urticaefolium*	North America
Hieracium species	Europe
Lactuca scariola var. integrata*	North America
Sonchus asper	Europe
Sonchus oleraceus*	North America

CRUCIFERAE

Arabis laevigata	North America
Barbarea vulgaris*	North America
Brassica napus	North America
Brassica oleracea*	North America
Brassica rapa	North America
Raphanus sativus*	North America
Sisymbrium officinale	North America

CUCURBITACEAE

Citrullus vulgaris	North America

EUPHORBIACEAE	
Euphorbia amygdaloides	Europe
Euphorbia cyparissias	Europe
GERANIACEAE	
Tropaeolum minus*	North America
GRAMINEAE	
Hordeum vulgare	North America
Secale cereale	North America
Triticum sativum	Europe
Zea mays	North America
LABIATAE	
Galeopsis pubescens	Europe
Galeopsis tetrahit	Europe
Galeopsis versicolor	Europe
Stachys sylvantrica	Europe
LEGUMINOSAE	
Lathyrus odoratus	North America
Lathyrus silvestris	Europe
Medicago sativa*	North America
Melilotus alba*	North America
Pisum sativum*	North America
Trifolium medium	North America
Trifolium pratense*	North America
Trifolium repens	North America
Trigonella foenum-graecum	North America
Vigna ungiculata	North America
MALVACEAE	
Gossypium barbadense	North America
Gossypium herbaceum	North America
Malva rotundifolia	North America
PLANTAGINACEAE	
Plantago species	North America
ROSACEAE	
Spiraea ulmaria	Denmark
SOLANACEAE	
Capsicum species	North America
Hyoscyamus niger	Denmark
Nicotiana species	North America
Solanum nigrum	Denmark
Solanum tuberosum	North America
VALERIANACEAE	
Valeriana officinalis	Europe
Agromyza pygmaea Meig.	
GRAMINEAE	
Brachypodium sylvaticum	Europe
Dactylis glomerata	Europe

Agromyza reptans Fall.

COMPOSITAE	
Artemisia vulgaris	Denmark
ROSACEAE	
Potentilla anserina	Europe
URTICACEAE	
Urtica dioica	Europe
Urtica urens	Europe

Agromyza reptans var. *subnigripes* Mall.

CARYOPHYLLACEAE	
Stellaria media	Denmark
COMPOSITAE	
Ambrosia artemisiifolia*	North America
Ambrosia trifida*	North America
Helianthus annuus*	North America
GRAMINEAE	
Phragmites communis	Denmark
Saccharum officinarum	Russia
LEGUMINOSAE	
Medicago sativa	Europe
Onobrychis sativa	Europe
URTICACEAE	
Laportea canadensis*	North America
Urtica gracilis*	North America

Agromyza rubi Brischke

ROSACEAE	
Rubus idaeus	Europe
Sanguisorba officinalis	Europe

Agromyza rufipes Meig.

BORAGINACEAE	
Anchusa officinalis	Europe
Asperugo procumbens	Europe
Cerinthe minor	Europe
Cynoglossum cheirifolium	Europe
Cynoglossum officinale	Europe
Echium vulgare	Europe
Lithospermum officinale	Europe
Lithospermum purpureo-caeruleum	Europe
Myosotis silvatica	Europe
Pulmonaria officinalis	Europe
Symphytum officinale	Europe
Symphytum tuberosum	Europe

Agromyza salicifolii Collin

SALICACEAE	
Salix species	Africa

Agromyza salicina Hendel

SALICACEAE

Salix repens	Europe

Agromyza scutellata Fall.

CHENOPODIACEAE

Chenopodium botrys	North America

COMPOSITAE

Carduus spinossimus	North America
Dahlia variabilis	North America
Helianthus annuus	North America
Xanthium canadense	North America

GRAMINEAE

Zea mays	North America

HAMAMELIDACEAE

Liquidambar styraciflua	North America

LEGUMINOSAE

Medicago sativa	North America

LOBELIACEAE

Lobelia cardinalis	North America

VITACEAE

Psedera quinquefolia	North America

Agromyza scutellata Zett.

LEGUMINOSAE

Vicia cracca	Europe
Vicia faba	Europe

Agromyza setosa Loew (doubtful)

COMPOSITAE

Aster species	Europe

GRAMINEAE

Zizania aquatica	Europe

Agromyza solidaginis Kaltb.

COMPOSITAE

Solidago virgaurea	Europe

Agromyza sordida Brischke

BORAGINACEAE

Lycopsis arvensis	Europe

LABIATAE

Lamium purpureum	Europe

Agromyza spiraeae Kaltb.

ROSACEAE

Fragaria moschata	Europe
Geum species	Europe
Potentilla anserina	Europe
Potentilla reptans	Europe
Rubus species	Europe
Sanguisorba officinalis	Europe
Spiraea species	Europe

Agromyza strigata Meig. (See also *A. pusilla* Meig.)

CAMPANULACEAE

Campanula glomerata	Europe
Campanula rapunculoides	Europe
Campanula trachelium	Europe

COMPOSITAE

Aster amellus	Europe
Bellis perennis	Europe
Hieracium murorum	Europe
Hieracium umbellatum	Europe
Sonchus arvensis	Europe
Sonchus oleraceus	Europe
Taraxacum officinale	Europe

URTICACEAE

Cannabis gigantea	Europe

Agromyza thapsi Bouché

SCROPHULARIACEAE

Verbascum thapsus	Europe

Agromyza theae Bigot. (See *Oscinis theae* Bigot, Oscinidae, page 170.)

Agromyza trifolii Kaltb.

LEGUMINOSAE

Trifolium species	Europe

Agromyza ulmi n. sp.

URTICACEAE

Ulmus americana	North America

Agromyza umbrina Watt

SCROPHULARIACEAE

Veronica salicifolia	New Zealand
Veronica speciosa	New Zealand

Agromyza umbrinella Watt

SCROPHULARIACEAE

Veronica colensoi	New Zealand

Agromyza umbrosa Watt

SCROPHULARIACEAE	
Veronica monticola	New Zealand

Agromyza variegata Meig.

LEGUMINOSAE	
Astragalus colutea	Europe
Astragalus glycyphyllus	Europe
Colutea arborescens	Europe

Agromyza verbasci Bouché

SCROPHULARIACEAE	
Lychnitis (Verbascum) schraderi	Europe
Scrophularia alata	Europe
Scrophularia nodosa	Denmark
Verbascum nigrum	Denmark
Verbascum phlomoides	Europe
Verbascum thapsiforme	Denmark
Verbascum thapsus	Europe

Agromyza viciae Kaltb.

LEGUMINOSAE	
Vicia cracca	Europe
Vicia sepium	Europe

Agromyza viridula Coq.

FAGACEAE	
Quercus rubra	North America

Agromyza xanthocephala Zett.

CARYOPHYLLACEAE	
Lychnis dioica	Europe
Lychnis githago	Europe
Lychnis haageana	Europe
Saponaria officinalis	Europe
Silene inflata	Europe
Silene nutans	Europe

Agromyza n. sp. near *luctuosa* Meig.

CYPERACEAE	
Cyperus acuminatus	North America

Agromyza n. sp. near *pruinosa* Coq.

URTICACEAE	
Humulus lupulus	North America

Agromyza species

CYPERACEAE	
Scirpus fluviatilis	North America
SALICACEAE	
Populus carolina	North America

Anthomyza coffeae Neinter (doubtful)

RUBIACEAE

Coffea arabica	Ceylon

Cerodonta femoralis Meig.

GRAMINEAE

Andropogon sorghum	North America
Avena sativa*	North America
Bromus carinatus	North America
Dactylis glomerata*	North America
Echinochloa crusgalli	North America
Eleusine indica*	North America
Elymus glaucus	North America
Eragrostis species	North America
Hordeum murinum	North America
Hordeum vulgare	North America
Panicum capillare*	North America
Panicum dichotomiflorum	North America
Panicum miliaceum	North America
Panicum sanguinale*	North America
Phalaris minor	North America
Phleum pratense*	North America
Poa pratensis	North America
Secale cereale	North America
Setaria viridis*	North America
Syntherisma sanguinale	North America
Triticum sativum	North America
Zea mays	North America

LEGUMINOSAE

Medicago sativa	North America
Vigna sinensis	North America

Dizygomyza labiatarum Hendel

LABIATAE

Ballota nigra	Europe
Galeopsis tetrahit	Europe
Glechoma (Nepeta) hederacea	Europe
Lamium maculatum	Europe
Leonurus cardiaca	Europe
Stachys sylvantrica	Europe

Dizygomyza morosa Meig.

IRIDACEAE

Iris foedita	Europe
Iris pseudacorus	Europe

Domomyza ambigua Fall.

GRAMINEAE

Hordeum murinum	Europe

Domomyza mobilis Meig.

BETULACEAE	
Alnus glutinosa	Europe
Alnus incana	Europe
Betula alba	Europe
Betula incana	Europe
BORAGINACEAE	
Cynoglossum officinale	Europe
LEGUMINOSAE	
Medicago falcata	Europe
SALICACEAE	
Populus tremula	Europe
URTICACEAE	
Urtica dioica	Europe
Urtica urens	Europe

Liriomyza virgo Zett.

EQUISETACEAE	
Equisetum palustre	Europe

Melanagromyza cunctata Hendel

EUPHORBIACEAE	
Euphorbia gerardiana	Europe

Napomyza gentii Hendel

GENTIANACEAE	
Gentiana lutea	Europe

Napomyza heringii Hendel

OLEACEAE	
Fraxinus excelsior	Europe

Napomyza lateralis Fall.

CAPRIFOLIACEAE	
Lonicera periclymenum	Europe
Lonicera tatarica	Europe
COMPOSITAE	
Chrysanthemum species	Europe, North America
Inula britannica	Europe
Matricaria inodora	Europe
Pyrethrum inodorum	Europe
Sonchus oleraceus	Europe
SCROPHULARIACEAE	
Verbascum thapsus	Europe

Phytomyza abdominalis Zett.

RANUNCULACEAE	
Anemone hepatica	Europe

Phytomyza aconiti Hendel

RANUNCULACEAE

Aconitum species	Europe
Delphinium species	Europe

Phytomyza affinis Fall.

CHENOPODIACEAE

Spinacia oleracea	Europe

COMPOSITAE

Arctium lappa	Europe
Chrysanthemum species	Australia
Cirsium arvense	Europe
Cirsium oleraceum	Europe
Erigeron canadensis	Europe
Eupatorium cannabinum	Europe
Helianthus annuus	Australia
Senecio elegans	Europe
Tussilago farfara	Europe

CRUCIFERAE

Brassica campestris	North America
Brassica rapa	?

LEGUMINOSAE

Medicago falcata	Europe
Medicago sativa	Europe
Pisum sativum	Europe

RANUNCULACEAE

Aconitum napellus	Europe

UMBELLIFERAE

Pastinaca sativa	North America (?)

Phytomyza agromyzina Meig.

CORNACEAE

Cornus sanguinea	Europe

LABIATAE

Mentha aquatica	Europe

Phytomyza albiceps Meig.

BORAGINACEAE

Lithospermum arvense	Europe

CAPRIFOLIACEAE

Sambucus species	Europe
Symphoricarpos racemosus*	North America

CHENOPODIACEAE

Atriplex species	Europe

Phytonyza albiceps Meig. (*continued*)

CISTACEAE	
Helianthemum species	Europe
COMPOSITAE	
Arctium lappa	Europe
Artemisia vulgaris	Europe
Aster novae-angliae*	North America
Aster paniculatus*	North America
Aster undulatus*	North America
Bidens species	Europe
Centaurea jacea	Europe
Chrysanthemum inodorum	Europe
Chrysanthemum leucanthemum	Europe
Chrysanthemum vulgare	Europe
Cirsium arvense	Europe
Cirsium oleraceum	Europe
Erechtites arguta	New Zealand
Erechtites praemanthoides	New Zealand
Eupatorium cannabinum	Europe
Onopordum acanthium	New Zealand
Senecio jacobaea	Europe
Senecio vulgaris	Europe
Solidago caesia*	North America
Solidago nemoralis*	North America
Sonchus arvensis	New Zealand
Sonchus asper	New Zealand
Sonchus oleraceus	Europe
Tanacetum vulgare	Europe
Taraxacum species	Europe
LABIATAE	
Ballota species	Europe
Leonurus cardiaca	Europe
LEGUMINOSAE	
Lathyrus species	Europe
Melilotus species	New Zealand
Pisum sativum	North America
PAPAVERACEAE	
Papaver rhoeas	Europe
PLANTAGINACEAE	
Plantago major	North America
RANUNCULACEAE	
Aconitum napellus	Europe
UMBELLIFERAE	
Heracleum lanatum	North America
Pastinaca sativa*	North America
Pimpinella magna	Europe
VALERIANACEAE	
Valerianella olitoria	Europe

Phytomyza ancholiae R-D.

RANUNCULACEAE

Aquilegia canadensis	Europe
Aquilegia vulgaris	Europe

Phytomyza angelica Kaltb.

UMBELLIFERAE

Angelica sylvestris	Europe

Phytomyza aquifolii Gour.

AQUIFOLIACEAE

Ilex aquifolium	Europe, North America

Phytomyza aquilegiae Hardy

GERANIACEAE

Tropaeolum minus	North America

RANUNCULACEAE

Aquilegia canadensis*	North America
Aquilegia vulgaris*	North America

Phytomyza artemisiae Kaltb.

COMPOSITAE

Artemisia absinthium	Europe
Artemisia vulgaris	Europe
Chrysanthemum parthenium	Europe
Tanacetum vulgare	Europe

Phytomyza atra Meig.

LABIATAE

Glechoma (Nepeta) hederacea	Europe

LEGUMINOSAE

Trifolium repens	Europe

UMBELLIFERAE

Pastinaca sativa	Europe

Phytomyza atricornis Meig.

COMPOSITAE

Ambrosia artemisiifolia	Europe
Centaurea jacea	Europe
Erigeron acer	Europe
Helianthus annuus	Europe
Lactuca species	Europe
Senecio elegans	Europe
Sonchus oleraceus	Europe

CRUCIFERAE

Isatis tinctoria	Europe
Lepidium draba	Europe
Sinapis (Brassica) alba	Europe

DIPSACACEAE

Knautia arvensis	Europe
Knautia scabiosa	Europe

LABIATAE

Galeopsis pubescens	Europe
Galeopsis tetrahit	Europe

LEGUMINOSAE

Ononis spinosa	Europe
Phaseolus multiflorus	Europe
Pisum sativum	Europe

PAPAVERACEAE

Papaver somniferum	Europe

POLEMONIACEAE

Phlox drummondi	Europe

SCROPHULARIACEAE

Linaria vulgaris	Europe

Phytomyza bipunctata Loew

COMPOSITAE

Echinops sphaerocephalus	Europe

Phytomyza brischkei Hendel

LEGUMINOSAE

Trifolium repens	Europe

Phytomyza brunnea Brischke

RANUNCULACEAE

Ranunculus repens	Europe

Phytomyza brunnipes Brischke

UMBELLIFERAE

Sanicula europaea	Europe

Phytomyza campanulae Hendel

CAMPANULACEAE

Campanula trachelium	Europe

Phytomyza chaerophylli Kaltb.

UMBELLIFERAE

Anthriscus silvestris	Europe
Chaerophyllum tremulum	Europe
Selinum curvifolia	Europe
Torilis anthriscus	Europe

Phytomyza chrysanthemi Kowarz

COMPOSITAE

Ambrosia artemisiifolia	North America
Antennaria plantaginifolia	North America
Bidens frondosa	North America
Chrysanthemum frutescens	North America
Chrysanthemum indicum	North America
Chrysanthemum leucanthemum	North America
Chrysanthemum morifolium	North America
Chrysanthemum parthenifolium	North America
Chrysanthemum parthenium	North America
Chrysanthemum sinense	North America
Eupatorium species	North America
Gazania species	North America
Helianthus annuus	North America
Helianthus californicus	North America
Helianthus multiflorus	North America
Senecio cruentus	North America
Solidago nemoralis	North America
Tanacetum vulgare	North America
Taraxacum officinale	North America

CRUCIFERAE

Brassica oleracea	North America

LABIATAE

Glechoma (Nepeta) hederacea	Europe

LEGUMINOSAE

Pisum sativum	North America

PAPAVERACEAE

Papaver species	Europe

PLANTAGINACEAE

Plantago major*	North America

UMBELLIFERAE

Daucus carota	North America
Pastinaca sativa	North America

Phytomyza cicutae Hendel

UMBELLIFERAE

Cicuta virosa	Europe

Phytomyza cinerea Hendel

COMPOSITAE

Centaurea scabiosa	Europe

Phytomyza cinerefrons Hardy

GRAMINEAE

Hordeum vulgare	Europe

Phytomyza clematadi Watt

COMPOSITAE	
Erechtites arguta	New Zealand
Erechtites praemanthoides	New Zealand
RANUNCULACEAE	
Clematis indivisa	New Zealand

Phytomyza clematidis Loew

RANUNCULACEAE	
Clematis species	North America

Phytomyza conyzae Hendel

COMPOSITAE	
Inula conyza	Europe

Phytomyza corni Kaltb.

CORNACEAE	
Cornus sanguinea	Europe

Phytomyza crassiseta Zett.

COMPOSITAE	
Dahlia species	Europe

Phytomyza cytisi Brischke

LEGUMINOSAE	
Cytisus laburnum	Europe

Phytomyza fallaciosa Loew

BORAGINACEAE	
Symphytum officinale	Europe
COMPOSITAE	
Eupatorium cannabinum	Europe
Lappa (Arctium) major	Europe
Lappa (Arctium) minor	Europe
Lappa (Arctium) officinalis	Europe
Lappa (Arctium) tomentosa	Europe
Lapsana communis	Europe
RANUNCULACEAE	
Ranunculus bulbosus	Europe
Ranunculus langinosus	Europe
Ranunculus repens	Europe
UMBELLIFERAE	
Heracleum giganteum	Europe
Heracleum sibiricum	Europe
Pastinaca sativa	Europe
Peucedanum (Lomatium) oreoselinum	Europe

Phytomyza fascialis Kaltb.

UMBELLIFERAE	
Bupleurum falcatum	Europe

Phytomyza femoralis Brischke

CRUCIFERAE

Brassica napus	Europe

Phytomyza flava Fall.

POLYPODIACEAE

Scolopendrium vulgare	Europe

RANUNCULACEAE

Ranunculus acris	Europe
Ranunculus bulbosus	Europe
Ranunculus flammula	Europe
Ranunculus langinosus	Europe
Ranunculus repens	Europe

UMBELLIFERAE

Chaerophyllum tremulum	Europe

Phytomyza flaviceps Westw.

CAPRIFOLIACEAE

Lonicera species	Europe

Phytomyza geniculata Macq.

BORAGINACEAE

Cynoglossum officinale	Europe
Cynoglossum omphaloides	Europe
Lithospermum arvense	Europe

CARYOPHYLLACEAE

Stellaria media	Europe

COMPOSITAE

Achillea ptarmica	Europe
Aster amellus	Europe
Bidens cernua	Europe
Calliopsis bicolor	Europe
Carduus crispus	Europe
Centaurea cyanus	Europe
Centaurea montana	Europe
Centaurea scabiosa	Europe
Chrysanthemum inodorum	Europe
Chrysanthemum leucanthemum	Europe
Chrysanthemum parthenium	Europe
Cichorium intybus	Europe
Cirsium arvense	Europe
Cirsium heterophyllum	Europe
Cirsium lanceolatum	Europe
Cirsium oleraceum	Europe
Cirsium palustre	Europe
Cirsium sativus	Europe
Dahlia variabilis	Europe
Eupatorium cannabinum	Europe
Gaillardia picta	Europe

Helianthus annuus	Europe
Helianthus tuberosus	Europe
Helichrysum brateatum	Europe
Lappa (Arctium) major	Europe
Lapsana communis	Europe
Leontodon autumnalis	Europe
Leontodon radiatus	Europe
Onopordum acanthium	Europe
Senecio elegans	Europe
Senecio jacobaea	Europe
Senecio vulgaris	Europe
Sonchus arvensis	Europe
Sonchus asper	Europe
Sonchus oleraceus	Europe
Tanacetum balsamita	Europe
Tanacetum vulgare	Europe
Taraxacum officinale	Europe
Tussilago farfara	Europe
CRUCIFERAE	
Brassica oleracea	Europe
Cheiranthus cheiri	Europe
Crambe maritima	Europe
Erysimum cheiranthoides	Europe
Farsetia incana	Europe
Hesperis matronalis	Europe
Raphanus raphanistrum	Europe
Sisymbrium loeselii	Europe
Sisymbrium officinale	Europe
Turritis glabra	Europe
CUCURBITACEAE	
Cucumis sativus	Europe
GERANIACEAE	
Tropaeolum majus	Europe
GRAMINEAE	
Phragmites communis	Europe
LABIATAE	
Galeopsis tetrahit	Europe
Galeopsis versicolor	Europe
LEGUMINOSAE	
Lupinus perennis	Europe
Melilotus vulgaris	Europe
Pisum sativum	Europe
LILIACEAE	
Allium cepa	Europe
MALVACEAE	
Althaea rosea	Europe
Malva rotundifolia	Europe

PAPAVERACEAE

Papaver rhoeas	Europe
Papaver somniferum	Europe

PLANTAGINACEAE

Plantago major	Europe

POLEMONIACEAE

Phlox decussata	Europe

RANUNCULACEAE

Aquilegia vulgaris	Europe
Ranunculus acris	Europe
Ranunculus bulbosus	Europe
Ranunculus langinosus	Europe
Ranunculus repens	Europe

SCROPHULARIACEAE

Antirrhinum majus	Europe

SOLANACEAE

Hyoscyamus niger	Europe

UMBELLIFERAE

Anethum graveolens	Europe
Levisticum officinale	Europe

Phytomyza glechomae Kaltb.

LABIATAE

Glechoma (Nepeta) arctia caja	Europe
Glechoma (Nepeta) callimorpha	Europe
Glechoma (Nepeta) hederacea	Europe
Salvia verticillata	Europe

LEGUMINOSAE

Trifolium pratense	Europe

Phytomyza hellebori Kaltb.

RANUNCULACEAE

Helleborus niger	Europe

Phytomyza helosciadii Kaltb.

UMBELLIFERAE

Helosciadium nodiflorum	Europe

Phytomyza hieracii Hendel

COMPOSITAE

Hieracium pilosella	Europe

Phytomyza ilicis Curt.

AQUIFOLIACEAE

Ilex aquifolium*	Europe, North America
Ilex glabra	Europe
Ilex opaca	Europe
Ilex verticillata var. tenuifolia	North America

Phytomyza lactuca n. sp.

COMPOSITAE

Lactuca scariola var. integrata*	North America

Phytomyza lappae Gour.

COMPOSITAE

Arctium lappa	Europe
Arctium tomentosum	Europe
Senecio fachsii	Europe
Senecio nomorensis	Europe

Phytomyza lappina R-D.

COMPOSITAE

Arctium lappa	Europe

Phytomyza linariae Kaltb.

SCROPHULARIACEAE

Antirrhinum majus	Europe
Antirrhinum orontium	Europe
Linaria vulgaris	Europe

Phytomyza lonicerae Brischke

CAPRIFOLIACEAE

Lonicera bella albida	Europe
Lonicera caerulea	Europe
Lonicera ledebouri	Europe
Lonicera minutiflora	Europe
Lonicera muendeniensis	Europe
Lonicera notha carneo	Europe
Lonicera regeliana	Europe
Lonicera segreziensis	Europe
Lonicera xylosteoides	Europe
Lonicera xylosteum	Europe
Symphoricarpos occidentalis	Europe
Symphoricarpos racemosus	Europe

Phytomyza marginella Fall.

UMBELLIFERAE

Peucedanum (Lomatium) cervaria	Europe

Phytomyza matricariae Hendel

COMPOSITAE

Achillea millefolium	Europe
Matricaria discoidea	Europe

Phytomyza melana Hendel

UMBELLIFERAE

Pimpinella saxifraga	Europe

Phytomyza milii Kaltb.

GRAMINEAE

Milium effusum	Europe
Poa annua	Europe

Phytomyza minuscula Gour.

RANUNCULACEAE

Aquilegia nigricans	Europe
Aquilegia vulgaris	Europe
Thalictrum species	Europe

Phytomyza nepetae Hendel

LABIATAE

Nepeta cataria	Europe

Phytomyza nigra Meig.

COMPOSITAE

Arctium species	Europe

RANUNCULACEAE

Aquilegia vulgaris	Europe

UMBELLIFERAE

Helosciadium nodiflorum	Europe
Heracleum sibiricum	Europe
Heracleum sphondylium	Europe

Phytomyza nigricans Macq.

CAPRIFOLIACEAE

Lonicera xylosteum	Europe

Phytomyza nitida Melander

COMPOSITAE

Ambrosia artemisiifolia*	North America
Tanacetum vulgare*	North America

LABIATAE

Nepeta cataria*	North America

RANUNCULACEAE

Thalictrum polygamum*	North America

Phytomyza obscura Hendel

COMPOSITAE

Arctium lappa	Europe

LABIATAE

Clinopodium vulgare	Europe
Galeopsis pubescens	Europe
Lycopus europaeus	Europe
Lycopus mentha	Europe

Phytomyza obscurella Fall.

AQUIFOLIACEAE	
Ilex aquifolium	Europe
CAPRIFOLIACEAE	
Diervilla lonicera	Europe
Lonicera periclymenum	Europe
Lonicera xylosteum	North America
Sambucus species	North America
Symphoricarpos racemosus	Europe
COMPOSITAE	
Chrysanthemum leucanthemum	?
CRASSULACEAE	
Sedum telephium	Europe
LEGUMINOSAE	
Lupinus albicaulis	North America
RANUNCULACEAE	
Actaea spicata	North America
Aquilegia vulgaris	Europe
UMBELLIFERAE	
Aegopodium podagraria	Europe
Anthriscus cerefolium	Europe
Anthriscus silvestris	Europe
Chaerophyllum aromaticum	Europe
Daucus carota	Europe
Pimpinella saxifraga	Europe
Selinum curvifolia	Europe

Phytomyza obscurella var. *nigritella* Zett.

CAPRIFOLIACEAE	
Diervilla lonicera*	North America
ROSACEAE	
Prunus persica*	North America
Prunus serotina*	North America

Phytomyza palliata Coq. (*Antineura palliata* Coq.)

PORTULACACEAE	
Portulaca species	North America

Phytomyza pauli-loewii Hendel

UMBELLIFERAE	
Peucedanum (Lomatium) oreoselinum	Europe
Pimpinella saxifraga	Europe

Phytomyza periclymeni de Meij.

CAPRIFOLIACEAE	
Lonicera periclymenum	Europe

Phytomyza plantaginis R-D.

PLANTAGINACEAE

Plantago lanceolata*	North America, Europe
Plantago major*	North America

SALICACEAE

Populus dilatata	Europe
Populus nigra	Europe
Populus tremula	Europe

Phytomyza plumiseta n. sp.

RANUNCULACEAE

Aquilegia canadensis*	North America
Thalictrum polygamum*	North America

Phytomyza populicola Haliday

SALICACEAE

Populus nigra	Europe

Phytomyza praecox Meig.

COMPOSITAE

Conyza squamosa	Europe
Inula britannica	Europe
Inula ensifolia	Europe
Inula hirta	Europe
Inula salicina	Europe

RANUNCULACEAE

Ranunculus acris	Europe
Ranunculus bulbosus	Europe
Ranunculus langinosus	Europe
Ranunculus repens	Europe

Phytomyza primulae R-D.

PRIMULACEAE

Primula acaulis	Europe
Primula grandiflora	Europe

Phytomyza ruficornis Zett.

CRUCIFERAE

Armoracia rusticana (Radicula armoracia)	Europe

Phytomyza scolopendri R-D.

POLYPODIACEAE

Scolopendrium officinale	Europe

Phytomyza sedi Kaltb.

CRASSULACEAE

Sedum album	Europe

Phytomyza senecionis Kaltb.

COMPOSITAE

Senecio nemorensis	Europe

Phytomyza similis Brischke

CORNACEAE

Cornus sanguinea	Europe

DIPSACACEAE

Knautia arvensis	Europe
Knautia silvatica	Europe

Phytomyza socia Brischke

RANUNCULACEAE

Anemone hepatica	Europe

Phytomyza solidaginis R-D.

COMPOSITAE

Aster amellus	Europe
Solidago virgaurea	Europe

PLANTAGINACEAE

Plantago lanceolata*	North America
Plantago major*	North America

Phytomyza sphondylii R-D.

COMPOSITAE

Petasites albus	Europe

UMBELLIFERAE

Heracleum sphondylium	Europe

Phytomyza tenella Meig.

COMPOSITAE

Aster species	Europe

Phytomyza tridentata Loew

SALICACEAE

Populus nigra	Europe
Salix fragilis	Europe

Phytomyza veronicae Kaltb.

SCROPHULARIACEAE

Veronica chamaedrys	Europe
Veronica officinalis	Europe
Veronica spicata	Europe

Phytomyza viduata Meig.

LEGUMINOSAE

Ononis species	Europe
Pisum species	Europe

Phytomyza vitalbae Kaltb.

CAPRIFOLIACEAE

Lonicera periclymenum	Europe
Lonicera xylosteum	Europe
Symphoricarpos racemosus	Europe

RANUNCULACEAE

Clematis vitalba	Europe

Phytomyza xylostei R-D.

CAPRIFOLIACEAE

Lonicera periclymenum	Europe
Lonicera xylosteum	Europe
Symphoricarpos racemosus	Europe

Phytomyza species

CAMPANULACEAE

Campanula glomerata	Europe

COMPOSITAE

Carlina vulgaris	Europe
Cirsium ochroleucum	Europe
Cirsium rivulare	Europe
Erigeron aurantiacus	Europe
Erigeron elongatus	Europe
Eupatorium perfoliatum	North America
Stenactis speciosa	Europe

DROSOPHILIDAE

Scaptomyza adusta Loew

AMARANTHACEAE

Amaranthus retroflexus	North America

CRUCIFERAE

Barbarea vulgaris*	North America
Brassica campestris*	North America
Brassica oleracea*	North America
Brassica rapa*	North America
Radicula armoracia*	North America
Raphanus sativus*	North America

LEGUMINOSAE

Pisum sativum*	North America

Scaptomyza flava Fall.

COMPOSITAE

Tussilago farfara	Europe

CRUCIFERAE

Brassica campestris	Europe
Brassica rapa	Europe

Scaptomyza flaveola Meig.

CRUCIFERAE

Brassica campestris	North America, Europe
Brassica oleracea	North America
Brassica oleracea var. botrytis	North America
Brassica rapa	North America
Cochlearia officinalis	North America, Europe
Raphanus sativus	North America
Stenophragma (Sisymbrium) thalianum	North America

GERANIACEAE

Tropaeolum canariense	North America, Europe

LEGUMINOSAE	
Anthyllis vulneraria	North America, Europe
Pisum sativum	North America, Europe
PAPAVERACEAE	
Papaver medicinale	North America
SOLANACEAE	
Solanum carolinense	North America
Scaptomyza graminum **Fall.**	
CARYOPHYLLACEAE	
Agrostemma githago	Europe
Lychnis githago	Europe
Silene armeria	Europe
Stellaria media	Europe
Viscaria oculata	Europe
CHENOPODIACEAE	
Chenopodium album	Europe
COMPOSITAE	
Petasites officinalis	North America
Tussilago farfara	Europe
CRUCIFERAE	
Brassica campestris	North America
Brassica oleracea	North America
Brassica rapa	North America
Cheiranthus cheiri	Europe
Diplotaxis tenuifolia	Europe
Raphanus raphanistrum	Europe
Raphanus sativus	Europe
DIPSACACEAE	
Knautia arvensis	Europe
Succisa pratensis	Europe
GERANIACEAE	
Tropaeolum majus	Europe
LEGUMINOSAE	
Anthyllis vulneraria	Europe
Pisum sativum	Europe
RANUNCULACEAE	
Aquilegia vulgaris	North America
Scaptomyza graminum **var.** ***flaveola*** **Meig.**	
CRUCIFERAE	
Brassica oleracea	Europe
Matthiola incana	Europe
Scaptomyza melanogaster **Meig.**	
BORAGINACEAE	
Symphytum officinale	Europe

Scaptomyza species

LABIATAE

Lamium album — Europe

ROSACEAE

Fragaria virginiana — ?

EPHYDRIDAE

Hydrellia griseola Fall.

CARYOPHYLLACEAE

Stellaria media — Europe

GRAMINEAE

Hordeum vulgare — Europe
Lolium perenne — Europe
Poa annua — Europe

LABIATAE

Lamium purpureum — Europe

Hydrellia leucostoma Meig.

CHENOPODIACEAE

Chenopodium album — Europe

Hydrellia scapularis Loew

GRAMINEAE

Hordeum species — North America

Hydrellia n. sp.

NAJADACEAE

Potamogeton amplifolius — North America

Hydrellia species

POLYGONACEAE

Polygonum amphibium — Europe
Polygonum persicaria — Europe

Notiphila flaveola Meig.

GERANIACEAE

Tropaeolum minus — Europe

PAPAVERACEAE

Papaver species — Europe

OSCINIDAE

Chlorops assimilis Macq. (doubtful)

CHENOPODIACEAE

Beta vulgaris — Europe

CRUCIFERAE

Radicula armoracia — Europe

GRAMINEAE

Poa pratensis — Europe

Crassiseta cornuta Fall. (doubtful)
GRAMINEAE
Phragmites communis — Europe

Oscinis coffeae de Meij. (doubtful)
RUBIACEAE
Coffea arabica — Ceylon

Oscinis theae Bigot (doubtful)
TERNSTROEMIACEAE
Camellia theifera — Ceylon

BORBORIDAE

Limosina species (doubtful)
COMPOSITAE
Arctium majus — Europe
Arctium tomentosum — Europe

CORDYLURIDAE

Parallelomma albipes Fall.
LILIACEAE
Convallaria polygonatum — Europe
Maianthemum bifolium — Europe

Parallelomma paridis Hendel
LILIACEAE
Paris quadrifolia — Europe

Parallelomma vittatum Meig.
ORCHIDACEAE
Epipactis palustris — Europe

ANTHOMYIIDAE

Chirosia crassiseta Stein
POLYPODIACEAE
Pteris aquilina — Europe

Chirosia parvicornis Zett.
POLYPODIACEAE
Pteris aquilina — Europe

Coenosia bilinella Zett. (doubtful)
COMPOSITAE
Cirsium arvense — Europe

Hylemyia betarum Lint.
CHENOPODIACEAE
Beta vulgaris — North America

Hylemyia cinerosa Zett.
POLYPODIACEAE
Pteris aquilina — Europe

Hylemyia floccosa Macq. (doubtful)

CHENOPODIACEAE

Beta vulgaris	North America

CRUCIFERAE

Brassica oleracea	North America

Hylemyia fugax Meig.

AMARANTHACEAE

Amaranthus retroflexus*	North America

CHENOPODIACEAE

Beta vulgaris*	North America
Chenopodium album*	North America
Spinacia oleracea*	Europe, North America

Hylemyia latipennis Zett.

POLYPODIACEAE

Athyrium (Asplenium) filix-femina	Europe

Hylemyia nigrescens Rond.

CARYOPHYLLACEAE

Dianthus caryophyllus	Europe

Hylemyia substriata Stein

CHENOPODIACEAE

Beta vulgaris	North America
Beta vulgaris var. macrorhiza	North America

Hylemyia transversalis Zett.

POLYGONACEAE

Rumex acetosa	Europe

Pegomyia bicolor Wied.

CARYOPHYLLACEAE

Stellaria media	Europe

COMPOSITAE

Cirsium palustre	Europe

POLYGONACEAE

Rumex acutus	Europe
Rumex crispus	North America
Rumex obtusifolius	North America
Rumex patientia	Europe

Pegomyia calyptrata Zett.

POLYGONACEAE

Rumex crispus*	North America
Rumex obtusifolius*	North America

Pegomyia genupuncta Stein

COMPOSITAE

Arctium lappa	Europe

Pegomyia grossa Brischke

CONVOLVULACEAE

Ipomoea versicolor	Europe

Pegomyia hyoscyami Panz.

AMARANTHACEAE

Amaranthus retroflexus*	North America

CARYOPHYLLACEAE

Silene species	Europe
Stellaria media	Europe

CHENOPODIACEAE

Atriplex hortensis	North America
Atriplex patula*	North America
Beta cicla*	North America
Beta vulgaris*	North America
Beta vulgaris var. macrorhiza	Europe
Chenopodium album*	North America
Chenopodium murale	Europe
Spinacia oleracea*	North America

COMPOSITAE

Arctium lappa	Europe
Carduus species	Europe
Onopordum acanthium	North America
Solidago virgaurea	Europe
Sonchus arvensis	Europe
Sonchus oleraceus	Europe
Taraxacum officinale	Europe

POLYGONACEAE

Polygonum amphibium	Europe
Polygonum persicaria	Europe

ROSACEAE

Spiraea species	Europe

SOLANACEAE

Atropa belladonna	Europe
Datura stramonium	Europe
Hyoscyamus niger	Europe
Solanum dulcamara	Europe

Pegomyia hystrix Brischke

POLYPODIACEAE

Pteris aquilina	Europe

Pegomyia incana Brischke

COMPOSITAE

Inula britannica	Europe
Inula cernua	Europe

Pegomyia milis Macq.

OXALIDACEAE

Oxalis species	Europe

POLYGONACEAE

Rumex species	Europe

Pegomyia nigritarsis Zett.

BORAGINACEAE

Symphytum officinale	Europe

CHENOPODIACEAE

Atriplex patula	Europe
Beta vulgaris	Europe
Chenopodium album	Europe

COMPOSITAE

Cirsium lanceolatum	Europe
Hieracium umbellatum	Europe

POLYGONACEAE

Polygonum amphibium	Europe
Polygonum persicaria	Europe
Rumex acetosa	Europe
Rumex aquaticus	Europe
Rumex crispus	Europe
Rumex obtusifolius	Europe

Pegomyia polygoni Kaltb.

POLYGONACEAE

Polygonum convolvulus	Europe
Polygonum dumetorum	Europe

Pegomyia ruficeps Stein (doubtful)

CHENOPODIACEAE

Beta vulgaris	North America

Pegomyia sulcans Rond.

CHENOPODIACEAE

Chenopodium species	Europe

Pegomyia vanduzeei Mall.

POLYGONACEAE

Rumex crispus*	North America
Rumex obtusifolius*	North America

Pegomyia versicolor Meig.

CHENOPODIACEAE

Beta trigna	Europe

COMPOSITAE

Inula britannica	Europe

Pegomyia winthemi Meig.

POLYGONACEAE

Rumex crispus	North America
Rumex obtusifolius	North America

Pegomyia species

POLYGONACEAE

Rumex acetosa	North America

HOST PLANTS OF LEAF-MINING DIPTERA OF THE WORLD

Abutilon theophrasti
Agromyza platyptera var. *jucunda* V. d. W.
Achillea millefolium
Phytomyza matricariae Hendel
Achillea ptarmica
Phytomyza geniculata Macq.
Aconitum napellus
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Aconitum species
Phytomyza aconiti Hendel
Actaea spicata
Phytomyza obscurella Fall.
Aegopodium podagraria
Phytomyza obscurella Fall.
Agropyron species
Agromyza inconspicua Mall.
Agrostemma githago
Scaptomyza graminum Fall.
Allium cepa
Phytomyza geniculata Macq.
Alnus glutinosa
Agromyza albitarsis Meig.
Domomyza mobilis Meig.
Alnus incana
Agromyza albitarsis Meig.
Domomyza mobilis Meig.
Althaea rosea
Agromyza platyptera var. *jucunda* V. d. W.
Phytomyza geniculata Macq.
Amaranthus retroflexus
Hylemyia fugax Meig.
Pegomyia hyoscyami Panz.
Scaptomyza adusta Loew
Amaranthus viridis
Agromyza pusilla Meig.
Ambrosia artemisiifolia
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza reptans var. *subnigripes* Mall.
Phytomyza atricornis Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza nitida Melander
Ambrosia trifida
Agromyza reptans var. *subnigripes* Mall.
Anchusa officinalis
Agromyza abiens Zett.
Agromyza rufipes Meig.
Andropogon sorghum
Cerodonta femoralis Meig.
Anemone hepatica
Phytomyza abdominalis Zett.
Phytomyza socia Brischke
Anethum graveolens
Phytomyza geniculata Macq.
Angelica sylvestris
Acidia heraclei Linn.
Phytomyza angelica Kaltb.
Antennaria plantaginifolia
Phytomyza chrysanthemi Kowarz
Anthriscus cerefolium
Phytomyza obscurella Fall.
Anthriscus silvestris
Phytomyza chaerophylli Kaltb.
Phytomyza obscurella Fall.
Anthyllis vulneraria
Agromyza nana Meig.
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
Antirrhinum majus
Phytomyza geniculata Macq.
Phytomyza linariae Kaltb.
Antirrhinum orontium
Phytomyza linariae Kaltb.
Apium graveolens
Acidia heraclei Linn.
Aplopappus squamosa
Agromyza platyptera var. *jucunda* V. d. W.
Aquilegia canadensis
Phytomyza ancholiae R-D.
Phytomyza aquilegiae Hardy
Phytomyza plumiseta n. sp.
Aquilegia nigricans
Phytomyza minuscula Gour.
Aquilegia vulgaris
Phytomyza ancholiae R-D.
Phytomyza aquilegiae Hardy
Phytomyza geniculata Macq.
Phytomyza minuscula Gour.
Phytomyza nigra Meig.
Phytomyza obscurella Fall.
Scaptomyza graminum Fall.
Arabis laevigata
Agromyza pusilla Meig.

Aralia nudicaulis
(A dipterous leaf-miner never reared)
Arctium bardana
Acidia lucida Fall.
Arctium lappa (*see also* Lappa)
Agromyza allecta Melander
Agromyza maculosa Mall.
Pegomyia genupuncta Stein
Pegomyia hyoscyami Panz.
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza lappae Gour.
Phytomyza lappina R-D.
Phytomyza obscura Hendel
Arctium majus
Acidia lucida Fall.
Limosina species (doubtful)
Spilographa zoe Loew
Arctium minus
Agromyza maculosa Mall.
Spilographa zoe Loew
Arctium tomentosum
Limosina species (doubtful)
Phytomyza lappae Gour.
Arctium species
Acidia cognata Wied.
Acidia heraclei Linn.
Phytomyza nigra Meig.
(*See also* Lappa.)
Armoracia rusticana (Radicula armoracia)
Phytomyza ruficornis Zett.
Artemisia absinthium
Phytomyza artemisiae Kaltb.
Spilographa artemisiae Fabr.
Artemisia discolor
Spilographa artemisiae Fabr.
Artemisia dracunculus
Spilographa artemisiae Fabr.
Artemisia graphaloides
Spilographa artemisiae Fabr.
Artemisia selengensis
Spilographa artemisiae Fabr.
Artemisia vulgaris
Acidia heraclei Linn.
Agromyza atripes Brischke
Agromyza reptans Fall.
Phytomyza albiceps Meig.
Phytomyza artemisiae Kaltb.
Spilographa artemisiae Fabr.
Asclepias incarnata
Agromyza pusilla Meig.
Asclepias syriaca
Agromyza pusilla Meig.
Asclepias tuberosa
Agromyza pusilla Meig.
Asperugo procumbens
Agromyza abiens Zett.
Agromyza rufipes Meig.
Asperula odorata
Agromyza morio Brischke
Asplenium flaccidum
Agromyza flavopleura Watt
Asplenium lucidum
Agromyza flavopleura var. *casta* Watt
Asplenium pinnatifidum
Agromyza felti Mall.
(*See also* Athyrium.)
Aster amellus
Agromyza atripes Brischke
Agromyza curvipalpis Zett.
Agromyza posticata Meig.
Agromyza strigata Meig.
Phytomyza geniculata Macq.
Phytomyza solidaginis R-D.
Aster arvensis
Agromyza curvipalpis var. *texana* Mall.
Agromyza posticata Meig.
Aster chinensis
Agromyza bellidis Kaltb.
Aster divaricatus
Agromyza curvipalpis var. *texana* Mall.
Aster ericoides
Agromyza platyptera var. *jucunda* V. d. W.
Aster laevis
Agromyza posticata Meig.
Aster novae-angliae
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *coronata* Loew
Agromyza posticata Meig.
Phytomyza albiceps Meig.
Aster paniculatus
Agromyza curvipalpis var. *texana* Mall.
Agromyza posticata Meig.
Phytomyza albiceps Meig.
Aster undulatus
Agromyza curvipalpis var. *texana* Mall.
Agromyza posticata Meig.
Phytomyza albiceps Meig.

Aster species
Agromyza maculosa Mall.
Agromyza setosa Loew (doubtful)
Phytomyza tenella Meig.
Astragalus colutea
Agromyza variegata Meig.
Astragalus glycyphyllus
Agromyza astragali
Agromyza variegata Meig.
Athyrium (Asplenium) filix-femina
Hylemyia latipennis Zett.
Atriplex hortensis
Pegomyia hyoscyami Panz.
Atriplex patula
Pegomyia hyoscyami Panz.
Pegomyia nigritarsis Zett.
Atriplex species
Phytomyza albiceps Meig.
Atropa belladonna
Pegomyia hyoscyami Panz.
Avena sativa
Agromyza coquilletti Mall.
Cerodonta femoralis Meig.
Ballota nigra
Agromyza lamii Kaltb.
Agromyza maura Meig.
Agromyza pulicaria Meig.
Dizygomyza labiatarum Hendel
Ballota species
Phytomyza albiceps Meig.
Barbarea vulgaris
Agromyza pusilla Meig.
Scaptomyza adusta Loew
Bellis perennis
Agromyza bellidis Kaltb.
Agromyza strigata Meig.
Beta cicla
Pegomyia hyoscyami Panz.
Beta trigna
Pegomyia versicolor Meig.
Beta vulgaris
Agromyza pusilla Meig.
Chlorops assimilis Macq. (doubtful)
Hylemyia betarum Lint.
Hylemyia floccosa Macq. (doubtful)
Hylemyia fugax Meig.
Hylemyia substriata Stein
Pegomyia hyoscyami Panz.
Pegomyia nigritarsis Zett.
Pegomyia ruficeps Stein (doubtful)
Beta vulgaris var. macrorhiza
Hylemyia substriata Stein
Pegomyia hyoscyami Panz.
Betonica palustris
Agromyza maura Meig.
Betula alba
Domomyza mobilis Meig.
Betula incana
Domomyza mobilis Meig.
Betula verrucosa
Agromyza albitarsis Meig.
Bidens cernua
Phytomyza geniculata Macq.
Bidens frondosa
Agromyza allecta Melander
Phytomyza chrysanthemi Kowarz
Bidens leucantha
Agromyza maculosa Mall.
Bidens species
Phytomyza albiceps Meig.
Brachypodium sylvaticum
Agromyza pygmaea Meig.
Brassica campestris
Phytomyza affinis Fall.
Scaptomyza adusta Loew
Scaptomyza flava Fall.
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
Brassica napus
Agromyza pusilla Meig.
Phytomyza femoralis Brischke
Brassica oleracea
Agromyza pusilla Meig.
Hylemyia floccosa Macq. (doubtful)
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Scaptomyza adusta Loew
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
Scaptomyza graminum var. *flaveola* Meig.
Brassica oleracea var. botrytis
Scaptomyza flaveola Meig.
Brassica rapa
Agromyza pusilla Meig.
Phytomyza affinis Fall.
Scaptomyza adusta Loew
Scaptomyza flava Fall.
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
(*See also* Sinapis.)
Bromus carinatus
Cerodonta femoralis Meig.
Bryonia dioica
Agromyza bryoniae Kaltb.
Bupleurum falcatum
Phytomyza fascialis Kaltb.
Buxus sempervirens
Monarthropalpus buxi Lab.

Calendula officinalis
(A dipterous leaf-miner never reared)
Calliopsis bicolor
Phytomyza geniculata Macq.
Camellia theifera
Oscinis theae Bigot (doubtful)
Campanula glomerata
Agromyza strigata Meig.
Phytomyza species
Campanula rapunculoides
Agromyza strigata Meig.
Campanula trachelium
Agromyza gyrans Fall.
Agromyza strigata Meig.
Phytomyza campanulae Hendel
Camptosorus rhizophyllus
Agromyza felti Mall.
Cannabis gigantea
Agromyza strigata Meig.
Capsicum species
Agromyza pusilla Meig.
Carduus crispus
Phytomyza geniculata Macq.
Carduus spinossimus
Agromyza scutellata Fall.
Carduus species
Acidia heraclei Linn.
Pegomyia hyoscyami Panz.
Carex hirta
Agromyza atra Meig.
Carlina vulgaris
Phytomyza species
Catalpa bungei
Agromyza clara Melander
Centaurea cyanus
Phytomyza geniculata Macq.
Centaurea jacea
Phytomyza albiceps Meig.
Phytomyza atricornis Meig.
Centaurea montana
Phytomyza geniculata Macq.
Centaurea scabiosa
Phytomyza cinerea Hendel
Phytomyza geniculata Macq.
Cerinthe minor
Agromyza rufipes Meig.
Chaerophyllum aromaticum
Phytomyza obscurella Fall.
Chaerophyllum tremulum
Phytomyza chaerophylli Kaltb.
Phytomyza flava Fall.
Cheiranthus cheiri
Phytomyza geniculata Macq.
Scaptomyza graminum Fall.
Chenopodium album
Hydrellia leucostoma Meig.
Hylemyia fugax Meig.
Pegomyia hyoscyami Panz.
Pegomyia nigritarsis Zett.
Scaptomyza graminum Fall.
Chenopodium botrys
Agromyza scutellata Fall.
Chenopodium murale
Pegomyia hyoscyami Panz.
Chenopodium species
Pegomyia sulcans Rond.
Chrysanthemum frutescens
Phytomyza chrysanthemi Kowarz
Chrysanthemum indicum
Agromyza maculosa Mall.
Phytomyza chrysanthemi Kowarz
Chrysanthemum inodorum
Agromyza abiens Zett.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Chrysanthemum lacustre
Spilographa artemisiae Fabr.
Chrysanthemum leucanthemum
Phytomyza albiceps Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Phytomyza obscurella Fall.
Spilographa artemisiae Fabr.
Spilographa zoe Loew
Chrysanthemum morifolium
Phytomyza chrysanthemi Kowarz
Chrysanthemum parthenifolium
Phytomyza chrysanthemi Kowarz
Spilographa artemisiae Fabr.
Chrysanthemum parthenium
Phytomyza artemisiae Kaltb.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Spilographa artemisiae Fabr.
Spilographa zoe Loew
Chrysanthemum sinense
Phytomyza chrysanthemi Kowarz
Chrysanthemum vulgare
Phytomyza albiceps Meig.
Chrysanthemum species
Acidia heraclei Linn.
Napomyza lateralis Fall.
Phytomyza affinis Fall.
Cichorium intybus
Agromyza pusilla Meig.
Phytomyza geniculata Macq.
Cicuta maculata
(A dipterous leaf-miner never reared)

Cicuta virosa
Phytomyza cicutae Hendel
Circaea lutetiana
Agromyza impatientis Brischke
Cirsium arvense
Acidia heraclei Linn.
Agromyza carbonaria Zett.
Coenosia bilinella Zett. (doubtful)
Phora rufipes Fall. (doubtful)
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Sciara species (doubtful)
Cirsium heterophyllum
Phytomyza geniculata Macq.
Cirsium lanceolatum
Pegomyia nigritarsis Zett.
Phytomyza geniculata Macq.
Cirsium ochroleucum
Phytomyza species
Cirsium oleraceum
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Cirsium palustre
Agromyza carbonaria Zett.
Pegomyia bicolor Wied.
Phytomyza geniculata Macq.
Cirsium rivulare
Phytomyza species
Cirsium sativus
Phytomyza geniculata Macq.
Citrullus vulgaris
Agromyza pusilla Meig.
Clematis indivisa
Phytomyza clematadi Watt
Clematis virginiana
(A dipterous leaf-miner never reared)
Clematis vitalba
Phytomyza vitalbae Kaltb.
Clematis species
Phytomyza clematidis Loew
Clianthus puniceus
Agromyza clianthi Watt
Clinopodium vulgare
Phytomyza obscura Hendel
Cnicus arvensis
Acidia heraclei Linn.
Cochlearia officinalis
Scaptomyza flaveola Meig.
Coffea arabica
Anthomyza coffeae Neinter (doubtful)
Oscinis coffeae de Meij. (doubtful)
Colutea arborescens
Agromyza variegata Meig.
Convallaria polygonatum
Parallelomma albipes Fall.
Conyza squamosa
Phytomyza praecox Meig.
Cornus amomum
(A dipterous leaf-miner never reared)
Cornus circinata
(A dipterous leaf-miner never reared)
Cornus sanguinea
Phytomyza agromyzina Meig.
Phytomyza corni Kaltb.
Phytomyza similis Brischke
Crambe maritima
Phytomyza geniculata Macq.
Crataegus species
(A dipterous leaf-miner never reared)
Cryptotaenia canadensis
Acidia heraclei Linn.
Cucumis sativus
Phytomyza geniculata Macq.
Cynara scolymus
Agromyza platyptera var. *jucunda* V. d. W.
Cynoglossum cheirifolium
Agromyza rufipes Meig.
Cynoglossum officinale
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza rufipes Meig.
Domomyza mobilis Meig.
Phytomyza geniculata Macq.
Cynoglossum omphaloides
Phytomyza geniculata Macq.
Cyperus acuminatus
Agromyza angulata Loew
Agromyza n. sp. near *luctuosa* Meig.
Cyrtandra paludosa
Dicranomyia foliocuniculator Swezey
Cytisus laburnum
Agromyza meijerei Hendel
Phytomyza cytisi Brischke
Cytisus scoparius
Agromyza anthracina Meig.
Agromyza pulicaria Meig.
Dactylis glomerata
Agromyza pygmaea Meig.
Cerodonta femoralis Meig.
Dactylis species
Agromyza atra Meig.

Dahlia variabilis
Agromyza scutellata Fall.
Phytomyza geniculata Macq.
Dahlia species
Phytomyza crassiseta Zett.
Datura stramonium
Pegomyia hyoscyami Panz.
Daucus carota
Phytomyza chrysanthemi Kowarz
Phytomyza obscurella Fall.
Delphinium staphisagria
Agromyza maura Meig.
Delphinium species
Phytomyza aconiti Hendel
Dianthus caryophyllus
Hylemyia nigrescens Rond.
Dianthus chinensis
Agromyza flavifrons Meig.
Diervilla lonicera
Phytomyza obscurella Fall.
Phytomyza obscurella var. *nigritella* Zett.
Diplotaxis tenuifolia
Scaptomyza graminum Fall.
Echinochloa crusgalli
Agromyza parvicornis Loew
Cerodonta femoralis Meig.
Echinops sphaerocephalus
Phytomyza bipunctata Loew
Echium vulgare
Agromyza echii Kaltb.
Agromyza rufipes Meig.
Eleusine indica
Cerodonta femoralis Meig.
Elymus canadensis
Agromyza coquilletti Mall.
Elymus glaucus
Cerodonta femoralis Meig.
Elymus virginicus
(A dipterous leaf-miner never reared)
Epipactis palustris
Parallelomma vittatum Meig.
Equisetum palustre
Liriomyza virgo Zett.
Eragrostis species
Cerodonta femoralis Meig.
Erechtites arguta
Phytomyza albiceps Meig.
Phytomyza clematadi Watt
Erechtites praemanthoides
Phytomyza albiceps Meig.
Phytomyza clematadi Watt
Erigeron acer
Phytomyza atricornis Meig.
Erigeron aurantiacus
Phytomyza species
Erigeron canadensis
Phytomyza affinis Fall.
Erigeron elongatus
Phytomyza species
Erigeron species
Agromyza platyptera var. *jucunda* V. d. W.
Erysimum cheiranthoides
Phytomyza geniculata Macq.
Eupatorium cannabinum
Agromyza fasciola Meig.
Agromyza pusilla Meig.
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza fallaciosa Loew
Phytomyza geniculata Macq.
Spilographa zoe Loew
Eupatorium odoratum
Agromyza eupatoriae Mall.
Eupatorium perfoliatum
Phytomyza species
Eupatorium purpureum
Agromyza allecta Melander
Agromyza pusilla Meig.
Eupatorium urticaefolium
Agromyza curvipalpis var. *texana* Mall.
Agromyza pusilla Meig.
Eupatorium species
Phytomyza chrysanthemi Kowarz
Euphorbia amygdaloides
Agromyza pusilla Meig.
Euphorbia cyparissias
Agromyza pusilla Meig.
Euphorbia gerardiana
Melanagromyza cunctata Hendel
Farsetia incana
Phytomyza geniculata Macq.
Festuca gigantea
Agromyza atra Meig.
Fragaria moschata
Agromyza spiraeae Kaltb.
Fragaria virginiana
Agromyza fragariae Mall.
Scaptomyza species
Fraxinus excelsior
Napomyza heringii Hendel
Gaillardia picta
Phytomyza geniculata Macq.
Galeopsis pubescens
Agromyza pusilla Meig.
Phytomyza atricornis Meig.
Phytomyza obscura Hendel

Galeopsis tetrahit
Agromyza pusilla Meig.
Dizygomyza labiatarum Hendel
Phytomyza atricornis Meig.
Phytomyza geniculata Macq.
Galeopsis versicolor
Agromyza pusilla Meig.
Phytomyza geniculata Macq.
Galium sylvaticum
Agromyza morio Brischke
Gazania species
Phytomyza chrysanthemi Kowarz
Gentiana lutea
Napomyza gentii Hendel
Geum urbanum
Agromyza gei Brischke
Geum species
Agromyza spiraeae Kaltb.
Glechoma (Nepeta) arctia caja
Phytomyza glechomae Kaltb.
Glechoma (Nepeta) callimorpha
Phytomyza glechomae Kaltb.
Glechoma (Nepeta) hederacea
Dizygomyza labiatarum Hendel
Phytomyza atra Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza glechomae Kaltb.
Gossypium barbadense
Agromyza pusilla Meig.
Gossypium herbaceum
Agromyza pusilla Meig.
Helianthemum species
Phytomyza albiceps Meig.
Helianthus annuus
Agromyza maculosa Mall.
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza reptans var. *subnigripes* Mall.
Agromyza scutellata Fall.
Phytomyza affinis Fall.
Phytomyza atricornis Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Helianthus californicus
Phytomyza chrysanthemi Kowarz
Helianthus multiflorus
Phytomyza chrysanthemi Kowarz
Helianthus tuberosus
Acidia heraclei Linn.
Acidia lucida Fall.
Phytomyza geniculata Macq.
Helichrysum brateatum
Phytomyza geniculata Macq.
Heliopsis helianthoides
(A dipterous leaf-miner never reared)
Helleborus niger
Phytomyza hellebori Kaltb.
Helosciadium nodiflorum
Phytomyza helosciadii Kaltb.
Phytomyza nigra Meig.
Heracleum asperum
Acidia heraclei Linn.
Heracleum giganteum
Acidia heraclei Linn.
Phytomyza fallaciosa Loew
Heracleum lanatum
Acidia heraclei Linn.
Agromyza platyptera var. *jucunda* V. d. W.
Phytomyza albiceps Meig.
Heracleum longifolium
Acidia heraclei Linn.
Heracleum sibiricum
Phytomyza fallaciosa Loew
Phytomyza nigra Meig.
Heracleum sphondylium
Acidia heraclei Linn.
Phytomyza nigra Meig.
Phytomyza sphondylii R-D.
Heracleum species
Agromyza heraclei Bouché
Hesperis matronalis
Phytomyza geniculata Macq.
Hieracium murorum
Agromyza hieracii Kaltb.
Agromyza strigata Meig.
Hieracium pilosella
Phytomyza hieracii Hendel
Hieracium umbellatum
Agromyza strigata Meig.
Pegomyia nigritarsis Zett.
Hieracium species
Agromyza pusilla Meig.
Hordeum jubatum
Agromyza coquilletti Mall.
Hordeum murinum
Agromyza nigripes Meig.
Cerodonta femoralis Meig.
Domomyza ambigua Fall.
Hordeum vulgare
Agromyza atra Meig.
Agromyza pusilla Meig.
Cerodonta femoralis Meig.
Hydrellia griseola Fall.
Phytomyza cinerefrons Hardy
Hordeum species
Hydrellia scapularis Loew

Humulus lupulus
Agromyza flaviceps Fall.
Agromyza frontalis Meig.
Agromyza n. sp. near *pruinosa* Coq.
Hydrophyllum canadense
(A dipterous leaf-miner never reared)
Hyoscyamus niger
Agromyza pusilla Meig.
Pegomyia hyoscyami Panz.
Phytomyza geniculata Macq.
Hystrix patula
Agromyza angulata Loew
Ilex aquifolium
Phytomyza aquifolii Gour.
Phytomyza ilicis Curt.
Phytomyza obscurella Fall.
Ilex glabra
Phytomyza ilicis Curt.
Ilex opaca
Phytomyza ilicis Curt.
Ilex verticillata var. tenuifolia
Phytomyza ilicis Curt.
Impatiens biflora
Agromyza borealis Mall.
Impatiens noli-tangere
Agromyza impatientis Brischke
Agromyza lutea Meig.
Impatiens pallida
Agromyza borealis Mall.
Impatiens parviflora
Agromyza impatientis Brischke
Inula britannica
Napomyza lateralis Fall.
Pegomyia incana Brischke
Pegomyia versicolor Meig.
Phytomyza praecox Meig.
Inula cernua
Pegomyia incana Brischke
Inula conyza
Phytomyza conyzae Hendel
Inula ensifolia
Phytomyza praecox Meig.
Inula hirta
Phytomyza praecox Meig.
Inula salicina
Phytomyza praecox Meig.
Ipomoea batatas
Agromyza platyptera var. *jucunda* V. d. W.
Ipomoea versicolor
Pegomyia grossa Brischke
Iris foedita
Dizygomyza morosa Meig.
Iris foetissima
Agromyza iraeos Dur.
Iris gigantea
Agromyza iraeos Dur.
Iris pseudacorus
Agromyza atra Meig.
Agromyza iraeos Dur.
Agromyza laminata Brischke
Agromyza nana Meig.
Dizygomyza morosa Meig.
Iris versicolor
Agromyza laterella Zett.
Isatis tinctoria
Phytomyza atricornis Meig.
Knautia arvensis
Phytomyza atricornis Meig.
Phytomyza similis Brischke
Scaptomyza graminum Fall.
Knautia scabiosa
Phytomyza atricornis Meig.
Knautia silvatica
Phytomyza similis Brischke
Lactuca scariola var. integrata
Agromyza pusilla Meig.
Phytomyza lactuca n. sp.
Lactuca species
Phytomyza atricornis Meig.
Lamium album
Agromyza lamii Kaltb.
Agromyza maura Meig.
Scaptomyza species
Lamium maculatum
Agromyza lamii Kaltb.
Dizygomyza labiatarum Hendel
Lamium purpureum
Agromyza sordida Brischke
Hydrellia griseola Fall.
Laportea canadensis
Agromyza reptans var. *subnigripes* Mall.
Lappa (Arctium) major
Phytomyza fallaciosa Loew
Phytomyza geniculata Macq.
Lappa (Arctium) minor
Phytomyza fallaciosa Loew
Lappa (Arctium) officinalis
Phytomyza fallaciosa Loew
Lappa (Arctium) tomentosa
Phytomyza fallaciosa Loew
Lapsana communis
Phytomyza fallaciosa Loew
Phytomyza geniculata Macq.
Lathyrus odoratus
Agromyza pusilla Meig.

Lathyrus silvestris
Agromyza pusilla Meig.
Lathyrus vernus
Agromyza orobi Hendel
Lathyrus species
Phytomyza albiceps Meig.
Leontodon autumnalis
Phytomyza geniculata Macq.
Leontodon radiatus
Phytomyza geniculata Macq.
Leonurus cardiaca
Agromyza lamii Kaltb.
Dizygomyza labiatarum Hendel
Phytomyza albiceps Meig.
Lepidium draba
Phytomyza atricornis Meig.
Levisticum officinale
Acidia heraclei Linn.
Phytomyza geniculata Macq.
Ligusticum species
Acidia heraclei Linn.
Linaria vulgaris
Phytomyza atricornis Meig.
Phytomyza linariae Kaltb.
Liquidambar styraciflua
Agromyza posticata Meig.
Agromyza scutellata Fall.
Liriodendron tulipifera
Thecodipolosis liriodendri O. S. (doubtful)
Lithospermum arvense
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Lithospermum officinale
Agromyza rufipes Meig.
Lithospermum purpureo-caeruleum
Agromyza rufipes Meig.
Lobelia cardinalis
Agromyza posticata Meig.
Agromyza scutellata Fall.
Lolium perenne
Hydrellia griseola Fall.
Lomaria filiformis
Agromyza flavopleura Watt
Lomatium. (*See* Peucedanum.)
Lonicera bella albida
Phytomyza lonicerae Brischke
Lonicera caerulea
Phytomyza lonicerae Brischke
Lonicera ledebouri
Phytomyza lonicerae Brischke
Lonicera minutiflora
Phytomyza lonicerae Brischke
Lonicera muendeniensis
Phytomyza lonicerae Brischke
Lonicera notha carneo
Phytomyza lonicerae Brischke
Lonicera periclymenum
Napomyza lateralis Fall.
Phytomyza obscurella Fall.
Phytomyza periclymeni de Meij.
Phytomyza vitalbae Kaltb.
Phytomyza xylostei R-D.
Lonicera regeliana
Phytomyza lonicerae Brischke
Lonicera segreziensis
Phytomyza lonicerae Brischke
Lonicera tatarica
Napomyza lateralis Fall.
Lonicera xylosteoides
Phytomyza lonicerae Brischke
Lonicera xylosteum
Phytomyza lonicerae Brischke
Phytomyza nigricans Macq.
Phytomyza obscurella Fall.
Phytomyza vitalbae Kaltb.
Phytomyza xylostei R-D.
Lonicera species
Phytomyza flaviceps Westw.
Lupinus albicaulis
Phytomyza obscurella Fall.
Lupinus perennis
Phytomyza geniculata Macq.
Luzula pilosa
Agromyza bimaculata Meig.
Lychnis dioica
Agromyza xanthocephala Zett.
Lychnis flos-cuculi
Agromyza flavifrons Meig.
Lychnis githago
Agromyza xanthocephala Zett.
Scaptomyza graminum Fall.
Lychnis haageana
Agromyza xanthocephala Zett.
Lychnis molachium
Agromyza flavifrons Meig.
Lychnitis (Verbascum) schraderei
Agromyza verbasci Bouché
Lycopersicon lycopersicum
(A dipterous leaf-miner not reared)
Lycopsis arvensis
Agromyza abiens Zett.
Agromyza posticata Meig.
Agromyza sordida Brischke
Lycopus europaeus
Phytomyza obscura Hendel
Lycopus mentha
Phytomyza obscura Hendel
Maianthemum bifolium
Parallelomma albipes Fall.

Malva rotundifolia
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza pusilla Meig.
Phytomyza geniculata Macq.
Matricaria discoidea
Phytomyza matricariae Hendel
Matricaria inodora
Napomyza lateralis Fall.
Matthiola incana
Scaptomyza graminum var. *flaveola* Meig.
Medicago falcata
Agromyza nana Meig.
Domomyza mobilis Meig.
Phytomyza affinis Fall.
Medicago sativa
Agromyza nigripennis Zett.
Agromyza nigripes Meig.
Agromyza posticata Meig.
Agromyza pusilla Meig.
Agromyza reptans var. *subnigripes* Mall.
Agromyza scutellata Fall.
Cerodonta femoralis Meig.
Phytomyza affinis Fall.
Melandrium album
Agromyza flavifrons Meig.
Melandrium rubrum
Agromyza flavifrons Meig.
Melicytus ramiflorus
Agromyza flavolateralis Watt
Melilotus alba
Agromyza pusilla Meig.
Melilotus officinalis
Agromyza nana Meig.
Melilotus vulgaris
Phytomyza geniculata Macq.
Melilotus species
Phytomyza albiceps Meig.
Mentha aquatica
Phytomyza agromyzina Meig.
Milium effusum
Phytomyza milii Kaltb.
Mitella diphylla
(A dipterous leaf-miner not reared)
Molinia coerulea
Agromyza atra Meig.
Myoporum laetum
Agromyza citreifemorata Watt
Myosotis silvatica
Agromyza rufipes Macq.
Nepeta cataria
Agromyza curvipalpis var. *texana* Mall.
Phytomyza nepetae Hendel
Phytomyza nitida Melander
(*See also* Glechoma.)
Nicotiana species
Agromyza pusilla Meig.
Ocimum basilicum
Agromyza platyptera var. *jucunda* V. d. W.
Onobrychis sativa
Agromyza nigripes Meig.
Agromyza reptans var. *subnigripes* Mall.
Onobrychis vicaefolia
Agromyza nana Meig.
Ononis repens
Agromyza orbona Meig.
Ononis spinosa
Agromyza orbona Meig.
Phytomyza atricornis Meig.
Ononis species
Phytomyza viduata Meig.
Onopordum acanthium
Acidia heraclei Linn.
Pegomyia hyoscyami Panz.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Oxalis species
Pegomyia milis Macq.
Panicum capillare
Cerodonta femoralis Meig.
Panicum commutatum
Agromyza parvicornis Loew
Panicum dichotomiflorum
Cerodonta femoralis Meig.
Panicum miliaceum
Agromyza parvicornis Loew
Cerodonta femoralis Meig.
Panicum sanguinale
Agromyza parvicornis Loew
Cerodonta femoralis Meig.
Papaver medicinale
Scaptomyza flaveola Meig.
Papaver rhoeas
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Papaver somniferum
Phytomyza atricornis Meig.
Phytomyza geniculata Macq.
Papaver species
Notiphila flaveola Meig.
Phytomyza chrysanthemi Kowarz
Parietaria officinalis
Agromyza anthracina Meig.
Paris quadrifolia
Parallelomma paridis Hendel

Paspalum dilatatum
Agromyza marginalis Mall.
Pastinaca sativa
Acidia heraclei Linn.
Agromyza atra Meig.
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza atra Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza fallaciosa Loew
Petasites albus
Phytomyza sphondylii R-D.
Petasites frigidus
Acidia lucida Fall.
Petasites neveus
Acidia lucida Fall.
Petasites officinalis
Acidia lucida Fall.
Scaptomyza graminum Fall.
Petasites species
Acidia cognata Wied.
Petroselinum petroselinum
Acidia heraclei Linn.
Peucedanum (Lomatium) cervaria
Phytomyza marginella Fall.
Peucedanum (Lomatium) oreoselinum
Phytomyza fallaciosa Loew
Phytomyza pauli-loewii Hendel
Phalaris minor
Cerodonta femoralis Meig.
Phaseolus lunatus
Agromyza inaequalis Mall.
Phaseolus multiflorus
Phytomyza atricornis Meig.
Phaseolus vulgaris
Agromyza platyptera var. *jucunda* V. d. W.
Philadelphus grandiflorus
Agromyza melampyga Loew
Phleum pratense
Agromyza angulata Loew
Agromyza laminata Brischke
Agromyza parvicornis Loew
Cerodonta femoralis Meig.
Phlox decussata
Phytomyza geniculata Macq.
Phlox drummondi
Phytomyza atricornis Meig.
Phragmites communis
Agromyza laminata Brischke
Agromyza nigripes Meig.
Agromyza phragmitidis Hendel
Agromyza reptans var. *subnigripes* Mall.
Crassiseta cornuta Fall. (doubtful)
Phora rufipes Fall. (doubtful)
Phytomyza geniculata Macq.
Sciara species (doubtful)
Pimpinella magna
Phytomyza albiceps Meig.
Pimpinella saxifraga
Phytomyza melana Hendel
Phytomyza obscurella Fall.
Phytomyza pauli-loewii Hendel
Pisum sativum
Agromyza pusilla Meig.
Phytomyza affinis Fall.
Phytomyza albiceps Meig.
Phytomyza atricornis Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Scaptomyza adusta Loew
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
Pisum species
Phytomyza viduata Meig.
Plantago lanceolata
Phytomyza plantaginis R-D.
Phytomyza solidaginis R-D.
Plantago major
Agromyza melampyga Loew
Phytomyza albiceps Meig.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Phytomyza plantaginis R-D.
Phytomyza solidaginis R-D.
Plantago maritima
Agromyza plantaginis Haliday
Oxyna plantaginis Haliday
Plantago species
Agromyza pusilla Meig.
Poa annua
Hydrellia griseola Fall.
Phytomyza milii Kaltb.
Poa pratensis
Cerodonta femoralis Meig.
Chlorops assimilis Macq. (doubtful)
Polygonatum biflorum
(A dipterous leaf-miner never reared)
Polygonatum commutatum
(A dipterous leaf-miner never reared)
Polygonum amphibium
Hydrellia species
Pegomyia hyoscyami Panz.
Pegomyia nigritarsis Zett.
Polygonum convolvulus
Pegomyia polygoni Kaltb.

Polygonum dumetorum
Pegomyia polygoni Kaltb.
Polygonum persicaria
Hydrellia species
Pegomyia hyoscyami Panz.
Pegomyia nigritarsis Zett.
Polypodium australe
Agromyza flavopleura Watt
Polypodium billardieri
Agromyza flavopleura Watt
Populus carolina
Agromyza species
Populus deltoides
(A dipterous leaf-miner never reared)
Populus dilatata
Phytomyza plantaginis R-D.
Populus nigra
Phytomyza plantaginis R-D.
Phytomyza populicola Haliday
Phytomyza tridentata Loew
Populus tremula
Agromyza albitarsis Meig.
Domomyza mobilis Meig.
Phytomyza plantaginis R-D.
Portulaca species
Antineura palliata Coq.
Potamogeton amplifolius
Hydrellia n. sp.
Potamogeton crispus
Chironomus species (not a true leaf-miner)
Potentilla anserina
Agromyza carbonaria Zett.
Agromyza potentillae Kaltb.
Agromyza reptans Fall.
Agromyza spiraeae Kaltb.
Potentilla reptans
Agromyza spiraeae Kaltb.
Prenanthes canadense
Acidia heraclei Linn.
Prenanthes trifoliolata
(A dipterous leaf-miner never reared)
Primula acaulis
Phytomyza primulae R-D.
Primula grandiflora
Phytomyza primulae R-D.
Prunus persica
Phytomyza obscurella var. *nigritella* Zett.
Prunus serotina
Phytomyza obscurella var. *nigritella* Zett.
Psedera quinquefolia
Agromyza posticata Meig.
Agromyza scutellata Fall.
Pteris aquilina
Agromyza hilarella Zett.
Chirosia crassiseta Stein
Chirosia parvicornis Zett.
Hylemyia cinerosa Zett.
Pegomyia hystrix Brischke
Pulmonaria officinalis
Agromyza rufipes Meig.
Pyrethrum inodorum
Napomyza lateralis Fall.
Pyrus malus
Agromyza minuta Meig.
Quercus rubra
Agromyza viridula Coq.
Radicula armoracia
Chlorops assimilis Macq. (doubtful)
Scaptomyza adusta Loew
(*See also* Armoracia rusticana.)
Ranunculus acris
Phytomyza flava Fall.
Phytomyza geniculata Macq.
Phytomyza praecox Meig.
Ranunculus bulbosus
Phytomyza fallaciosa Loew
Phytomyza flava Fall.
Phytomyza geniculata Macq.
Phytomyza praecox Meig.
Ranunculus flammula
Phytomyza flava Fall.
Ranunculus langinosus
Phytomyza fallaciosa Loew
Phytomyza flava Fall.
Phytomyza geniculata Macq.
Phytomyza praecox Meig.
Ranunculus repens
Phytomyza brunnea Brischke
Phytomyza fallaciosa Loew
Phytomyza flava Fall.
Phytomyza geniculata Macq.
Phytomyza praecox Meig.
Raphanus raphanistrum
Phytomyza geniculata Macq.
Scaptomyza graminum Fall.
Raphanus sativus
Agromyza pusilla Meig.
Scaptomyza adusta Loew
Scaptomyza flaveola Meig.
Scaptomyza graminum Fall.
Roripa species
Agromyza curvipalpis var. *texana* Mall.

Rubus alleghenienses
(A dipterous leaf-miner never reared)
Rubus idaeus
Agromyza fragariae Mall.
Agromyza rubi Brischke
Rubus odoratus
Agromyza fragariae Mall.
Rubus species (blackberry)
Agromyza fragariae Mall.
Rubus species (blackcap raspberry)
Agromyza fragariae Mall.
Rubus species
Agromyza spiraeae Kaltb.
Rudbeckia laciniata
(A dipterous leaf-miner never reared)
Rudbeckia laciniata var. flore-pleno
Agromyza platyptera var. *jucunda* V. d. W.
Rumex acetosa
Hylemyia transversalis Zett.
Pegomyia nigritarsis Zett.
Pegomyia species
Rumex acutus
Pegomyia bicolor Wied.
Rumex aquaticus
Acidia heraclei Linn.
Pegomyia nigritarsis Zett.
Rumex crispus
Pegomyia bicolor Wied.
Pegomyia calyptrata Zett.
Pegomyia nigritarsis Zett
Pegomyia vanduzeei Mall.
Pegomyia winthemi Meig.
Rumex obtusifolius
Pegomyia bicolor Wied.
Pegomyia calyptrata Zett.
Pegomyia nigritarsis Zett.
Pegomyia vanduzeei Mall.
Pegomyia winthemi Meig.
Rumex patientia
Pegomyia bicolor Wied.
Rumex species
Pegomyia milis Macq.
Saccharum officinarum
Agromyza reptans var. *subnigripes* Mall.
Salix fragilis
Phytomyza tridentata Loew
Salix nigra
(A dipterous leaf-miner never reared)
Salix repens
Agromyza salicina Hendel
Salix species
Agromyza salicifolii Collin
Salvia verticillata
Phytomyza glechomae Kaltb.
Sambucus ebalus
Agromyza pusilla Meig.
Sambucus nigra
Agromyza amoena Meig.
Sambucus racemosa
Agromyza amoena Meig.
Sambucus species
Phytomyza albiceps Meig.
Phytomyza obscurella Fall.
Sanguisorba officinalis
Agromyza rubi Brischke
Agromyza spiraeae Kaltb.
Sanicula europaea
Phytomyza brunnipes Brischke
Saponaria officinalis
Agromyza flavifrons Meig.
Agromyza xanthocephala Zett.
Scirpus fluviatilis
Agromyza species
Scolopendrium officinale
Phytomyza scolopendri R-D.
Scolopendrium vulgare
Phytomyza flava Fall.
Scrophularia alata
Agromyza verbasci Bouché
Scrophularia nodosa
Agromyza verbasci Bouché
Secale brandypodium
Agromyza atra Meig.
Secale cereale
Agromyza pusilla Meig.
Cerodonta femoralis Meig.
Sedum album
Phytomyza sedi Kaltb.
Sedum telephium
Phytomyza obscurella Fall.
Selinum curvifolia
Phytomyza chaerophylli Kaltb.
Phytomyza obscurella Fall.
Senecio aquatica
Spilographa zoe Loew
Senecio cruentus
Phytomyza chrysanthemi Kowarz
Senecio elegans
Phytomyza affinis Fall.
Phytomyza atricornis Meig.
Phytomyza geniculata Macq.

Senecio eurcifolius
Spilographa zoe Loew
Senecio fachsii
Phytomyza lappae Gour.
Senecio jacobaea
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Senecio nomorensis
Phytomyza lappae Gour.
Phytomyza senecionis Kaltb.
Senecio vulgaris
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Spilographa artemisiae Fabr.
Spilographa zoe Loew
Setaria glauca
Agromyza angulata Loew
Setaria viridis
Cerodonta femoralis Meig.
Silene armeria
Scaptomyza graminum Fall.
Silene inflata
Agromyza xanthocephala Zett.
Silene nutans
Agromyza xanthocephala Zett.
Silene pendula
Agromyza flavifrons Meig.
Silene vulgaris
Agromyza flavifrons Meig.
Silene species
Pegomyia hyoscyami Panz.
Sinapis (Brassica) alba
Phytomyza atricornis Meig.
Sisymbrium loeselii
Phytomyza geniculata Macq.
Sisymbrium officinale
Agromyza pusilla Meig.
Phytomyza geniculata Macq.
(*See also* Stenophragma.)
Sium latifolium
Acidia heraclei Linn.
Smilacina racemosa
(A dipterous leaf-miner never reared)
Solanum carolinense
Scaptomyza flaveola Meig.
Solanum dulcamara
Pegomyia hyoscyami Panz.
Solanum nigrum
Agromyza pusilla Meig.
Solanum tuberosum
Agromyza posticata Meig.
Agromyza pusilla Meig.

Solidago altissima
Agromyza platyptera var. *jucunda* V. d. W.
Solidago bicolor
Agromyza curvipalpis var. *texana* Mall.
Agromyza posticata Meig.
Solidago caesia
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *coronata* Loew
Agromyza posticata Meig.
Phytomyza albiceps Meig.
Solidago californica
Agromyza platyptera var. *jucunda* V. d. W.
Solidago canadensis
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *coronata* Loew
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza posticata Meig.
Solidago juncea
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *jucunda* V. d. W.
Agromyza posticata Meig.
Solidago latifolia
Agromyza curvipalpis var. *texana* Mall.
Agromyza platyptera var. *coronata* Loew
Agromyza posticata Meig.
Solidago nemoralis
Agromyza posticata Meig.
Phytomyza albiceps Meig.
Phytomyza chrysanthemi Kowarz
Solidago serotina
Agromyza curvipalpis var. *texana* Mall.
Agromyza posticata Meig.
Solidago virgaurea
Agromyza curvipalpis Zett.
Agromyza maura Meig.
Agromyza posticata Meig.
Agromyza pulicaria Meig.
Agromyza solidaginis Kaltb.
Pegomyia hyoscyami Panz.
Phytomyza solidaginis R-D.

Sonchus arvensis
Agromyza strigata Meig.
Pegomyia hyoscyami Panz.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Sonchus asper
Agromyza coniceps Mall.
Agromyza pusilla Meig.
Phytomyza albiceps Meig.
Phytomyza geniculata Macq.
Sonchus oleraceus
Agromyza lateralis Macq.
Agromyza pusilla Meig.
Agromyza strigata Meig.
Napomyza lateralis Fall.
Pegomyia hyoscyami Panz.
Phytomyza albiceps Meig.
Phytomyza atricornis Meig.
Phytomyza geniculata Macq.
Spinacia oleracea
Agromyza pusilla Meig.
Hylemyia fugax Meig.
Pegomyia hyoscyami Panz.
Phytomyza affinis Fall.
Spiraea ulmaria
Agromyza carbonaria Zett.
Agromyza pusilla Meig.
Spiraea species
Agromyza spiraeae Kaltb.
Pegomyia hyoscyami Panz.
Stachys sylvantrica
Agromyza pusilla Meig.
Dizygomyza labiatarum Hendel
Stellaria aquatica
Agromyza flavifrons Meig.
Stellaria holostea
Agromyza geniculata Fall.
Stellaria media
Agromyza flavifrons Meig.
Agromyza nigripes Meig.
Agromyza reptans var. *subnigripes* Mall.
Hydrellia griseola Fall.
Pegomyia bicolor Wied.
Pegomyia hyoscyami Panz.
Phytomyza geniculata Macq.
Scaptomyza graminum Fall.
Stenactis speciosa
Phytomyza species
Stenophragma (Sisymbrium) thalianum
Scaptomyza flaveola Meig.
Succisa pratensis
Scaptomyza graminum Fall.
Symphoricarpos occidentalis
Phytomyza lonicerae Brischke
Symphoricarpos racemosus
Phytomyza albiceps Meig.
Phytomyza lonicerae Brischke
Phytomyza obscurella Fall.
Phytomyza vitalbae Kaltb.
Phytomyza xylostei R-D.
Symphytum officinale
Agromyza ferruginosa V. d. W.
Agromyza lutea Meig.
Agromyza rufipes Meig.
Pegomyia nigritarsis Zett.
Phytomyza fallaciosa Loew
Scaptomyza melanogaster Meig.
Symphytum tuberosum
Agromyza rufipes Meig.
Syntherisma sanguinale
Cerodonta femoralis Meig.
Tanacetum balsamita
Phytomyza geniculata Macq.
Tanacetum vulgare
Phytomyza albiceps Meig.
Phytomyza artemisiae Kaltb.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Phytomyza nitida Melander
Spilographa artemisiae Fabr.
Taraxacum officinale
Agromyza maura var. *nasuta* Melander
Agromyza strigata Meig.
Pegomyia hyoscyami Panz.
Phytomyza chrysanthemi Kowarz
Phytomyza geniculata Macq.
Taraxacum species
Phytomyza albiceps Meig.
Thalictrum polygamum
Phytomyza nitida Melander
Phytomyza plumiseta n. sp.
Thalictrum species
Phytomyza minuscula Gour.
Torilis anthriscus
Phytomyza chaerophylli Kaltb.
Trifolium alpestre
Agromyza carbonaria Zett.
Trifolium arvense
Agromyza nana Meig.
Trifolium campestre
Agromyza nana Meig.
Trifolium incarnatum
Agromyza nana Meig.
Trifolium medium
Agromyza pusilla Meig.
Trifolium nana
Agromyza nana Meig.

Trifolium pratense
Agromyza carbonaria Zett.
Agromyza nana Meig.
Agromyza pusilla Meig.
Phytomyza glechomae Kaltb.
Trifolium repens
Agromyza carbonaria Meig.
Agromyza nana Meig.
Agromyza pusilla Meig.
Phytomyza atra Meig.
Phytomyza brischkei Hendel
Trifolium species
Agromyza trifolii Kaltb.
Trigonella foenum-graecum
Agromyza pusilla Meig.
Triticum repens
Agromyza atra Meig.
Agromyza laminata Brischke
Triticum sativum
Agromyza coquilletti Mall.
Agromyza parvicornis Loew
Agromyza pusilla Meig.
Cerodonta femoralis Meig.
Triticum vulgare
Agromyza coquilletti Mall.
Tropaeolum canariense
Scaptomyza flaveola Meig.
Tropaeolum majus
Phytomyza geniculata Macq.
Scaptomyza graminum Fall.
Tropaeolum minus
Agromyza posticata Meig.
Agromyza pusilla Meig.
Notiphila flaveola Meig.
Phytomyza aquilegiae Hardy
Turritis glabra
Phytomyza geniculata Macq.
Tussilago farfara
Acidia lucida Fall.
Acidia tussilaginis Fabr.
Phytomyza affinis Fall.
Phytomyza geniculata Macq.
Scaptomyza flava Fall.
Scaptomyza graminum Fall.
Tussilago species
Acidia cognata Wied.
Ulmus americana
Agromyza ulmi n. sp.
Urtica dioica
Agromyza anthracina Meig.
Agromyza reptans Fall.
Domomyza mobilis Meig.
Urtica gracilis
Agromyza reptans var. *subnigripes* Mall.
Urtica urens
Agromyza reptans Fall.
Domomyza mobilis Meig.
Valeriana officinalis
Agromyza fasciola Meig.
Agromyza pusilla Meig.
Valerianella olitoria
Phytomyza albiceps Meig.
Verbascum nigrum
Agromyza holosericea Bouché
Agromyza verbasci Bouché
Verbascum phlomoides
Agromyza verbasci Bouché
Verbascum thapsiforme
Agromyza verbasci Bouché
Verbascum thapsus
Agromyza macquarti Gour.
Agromyza thapsi Bouché
Agromyza verbasci Bouché
Napomyza lateralis Fall.
(*See also* Lychnitis.)
Verbena species
Agromyza platyptera var. *coronata* Loew
Agromyza platyptera var. *jucunda* V. d. W.
Veronica chamaedrys
Phytomyza veronicae Kaltb.
Veronica colensoi
Agromyza umbrinella Watt
Veronica monticola
Agromyza umbrosa Watt
Veronica officinalis
Phytomyza veronicae Kaltb.
Veronica salicifolia
Agromyza flavocentralis Watt
Agromyza umbrina Watt
Veronica speciosa
Agromyza flavocentralis Watt
Agromyza umbrina Watt
Veronica spicata
Phytomyza veronicae Kaltb.
Vicia cracca
Agromyza scutellata Zett.
Agromyza viciae Kaltb.
Vicia faba
Agromyza scutellata Zett.
Vicia sepium
Agromyza viciae Kaltb.
Victoria regia
Cricotopus sylvestris Fabr. (not a true leaf-miner)
Vigna repens
Agromyza inaequalis Mall.

Vigna sinensis
Cerodonta femoralis Meig.
Vigna ungiculata
Agromyza pusilla Meig.
Viola species
Agromyza platyptera var. *coronata* Loew
Viscaria oculata
Scaptomyza graminum Fall.
Xanthium canadense
Agromyza maculosa Mall.
Agromyza scutellata Fall.
Xanthium strumarium
Agromyza platyptera var. *jucunda* V. d. W.
Zea mays
Agromyza coquilletti Mall.
Agromyza neptis Loew (doubtful)
Agromyza parvicornis Loew
Agromyza pusilla Meig.
Agromyza scutellata Fall.
Cerodonta femoralis Meig.
Zinnia species
Agromyza platyptera var. *jucunda* V. d. W.
Zizania aquatica
Agromyza setosa Loew (doubtful)

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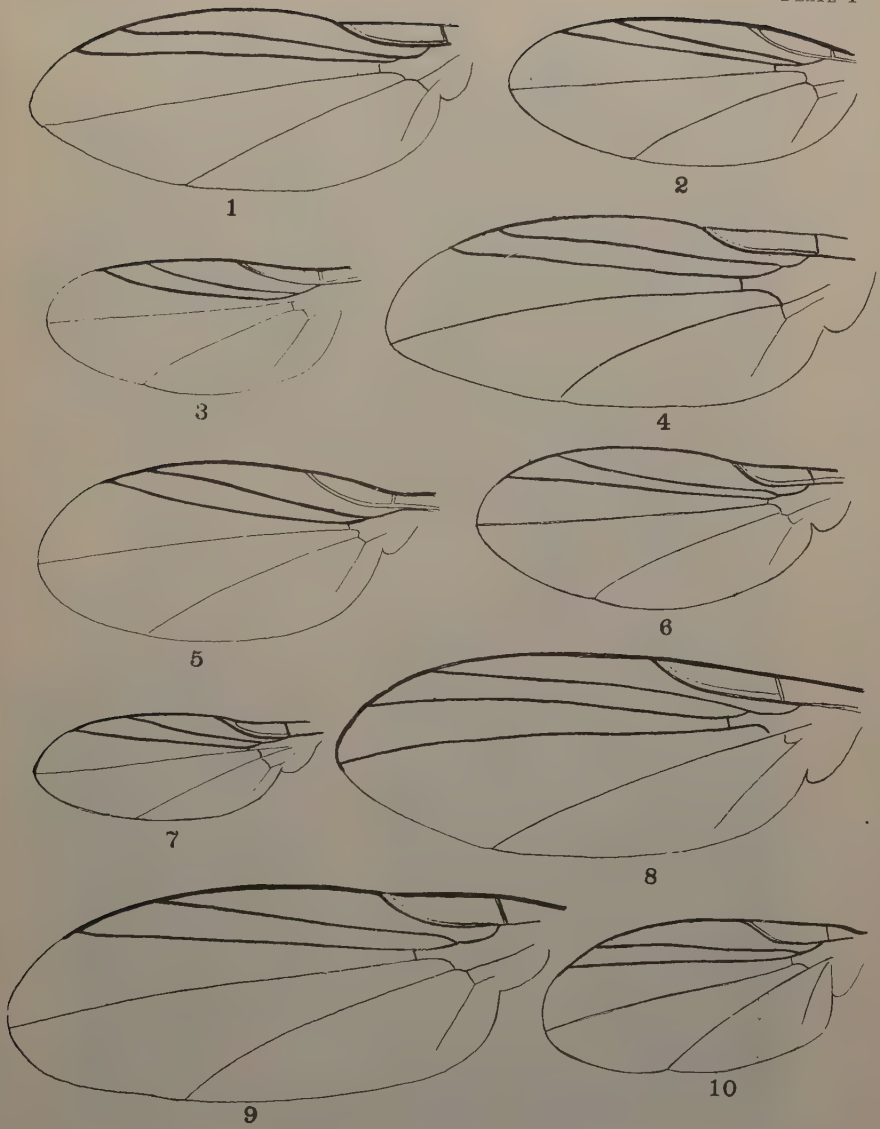
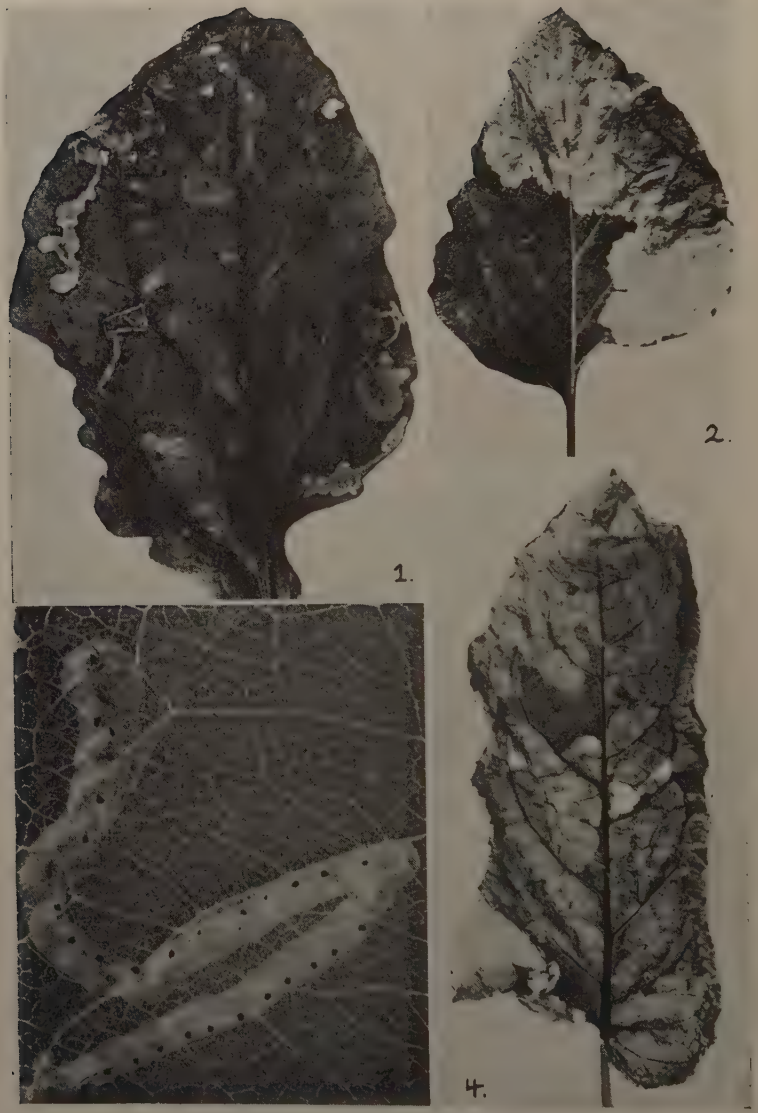
Memoir 67, *Observations on the Life History of Taphrocerus gracilis (Say) (Beetle, Family Buprestidae)*, the eleventh preceding number in this series of publications, was mailed on September 14, 1923.



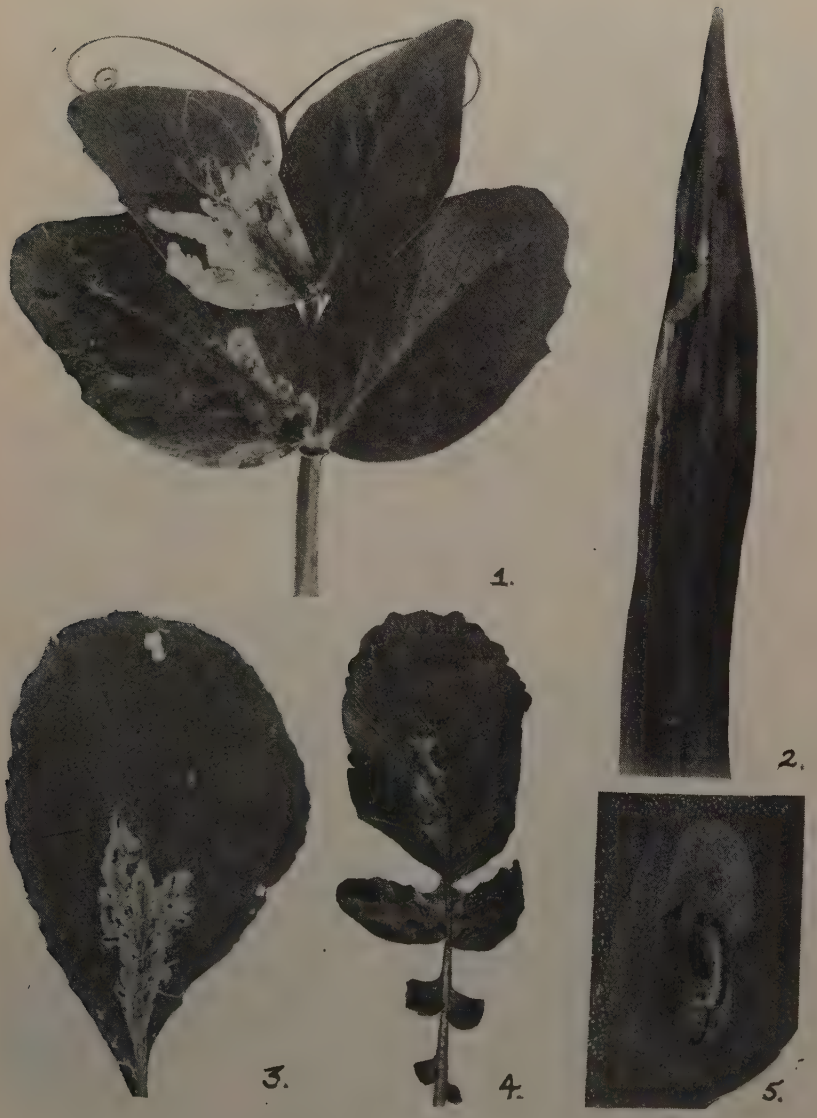
WINGS OF SPECIES OF PHYTOMYZA

1. *Phytomyza flava*; 2, *P. tenella*; 3, *P. melanella*; 4, *P. genalis*; 5, *P. nervosa*; 6, *P. aquifolii*; 7, *P. crassiseta*; 8, *P. nigripennis*; 9, *P. flavicornis*; 10, *P. ilicis*



MINES OF SOME DIPTERA

1, Mines of *Pegomyia hyoscyami* on beet; 2, of *Agromyza allecta* on *Arctium lappa*; 3, of *Phytomyza obscurella* var. *nigritella* on peach; 4, of *Pegomyia calyptrata* on *Rumex obtusifolius*

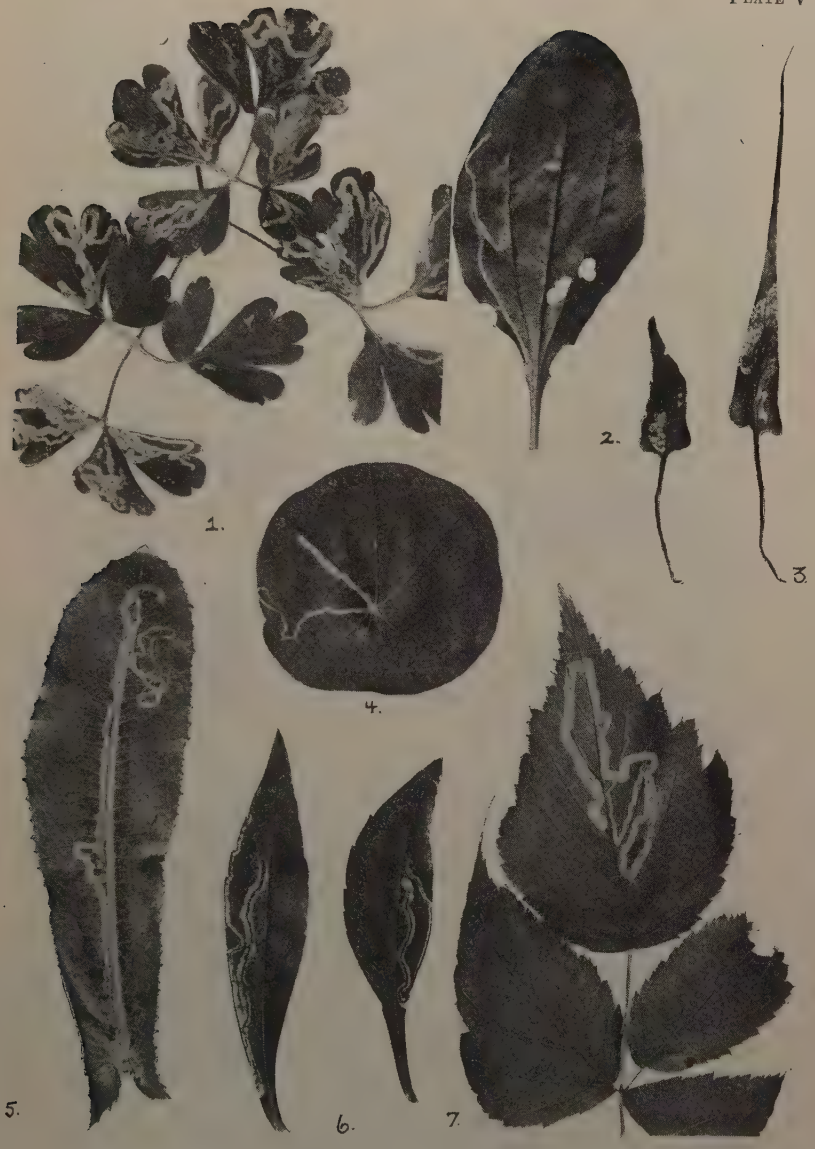


MINES OF SOME DIPTERA

1, Mines of *Scaptomyza adusta* on *Pisum sativum*; 2, of *Agromyza parvicornis* on *Zea mays*; 3, of *Scaptomyza adusta* on cabbage; 4, of *Scaptomyza adusta* on radish; 5, larva of *Pegomyia hyoscyami* beginning a mine on a fresh leaf

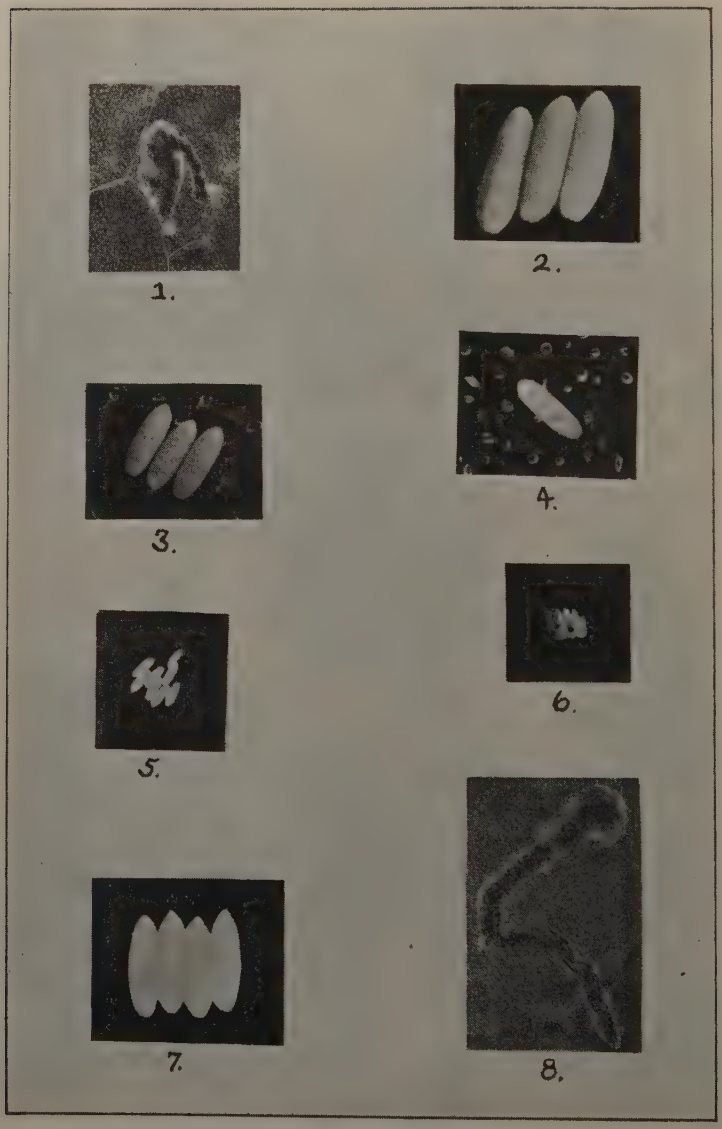
MINES OF SOME SPECIES OF AGROMYZA

1, Mines of *Agromyza melampyga* on *Philadelphus grandiflorus*; 2, of *A. curripalpis* on *Aster paniculatus*; 3, of *A. borealis* on *Impatiens biflora*; 4, of *A. posticata* on *Aster paniculatus*; 5, of *A. curripalpis* on *Solidago serotina*, upper side of leaf; 6, same, lower side of leaf; 7, of *A. pusilla* on *Trifolium repens*



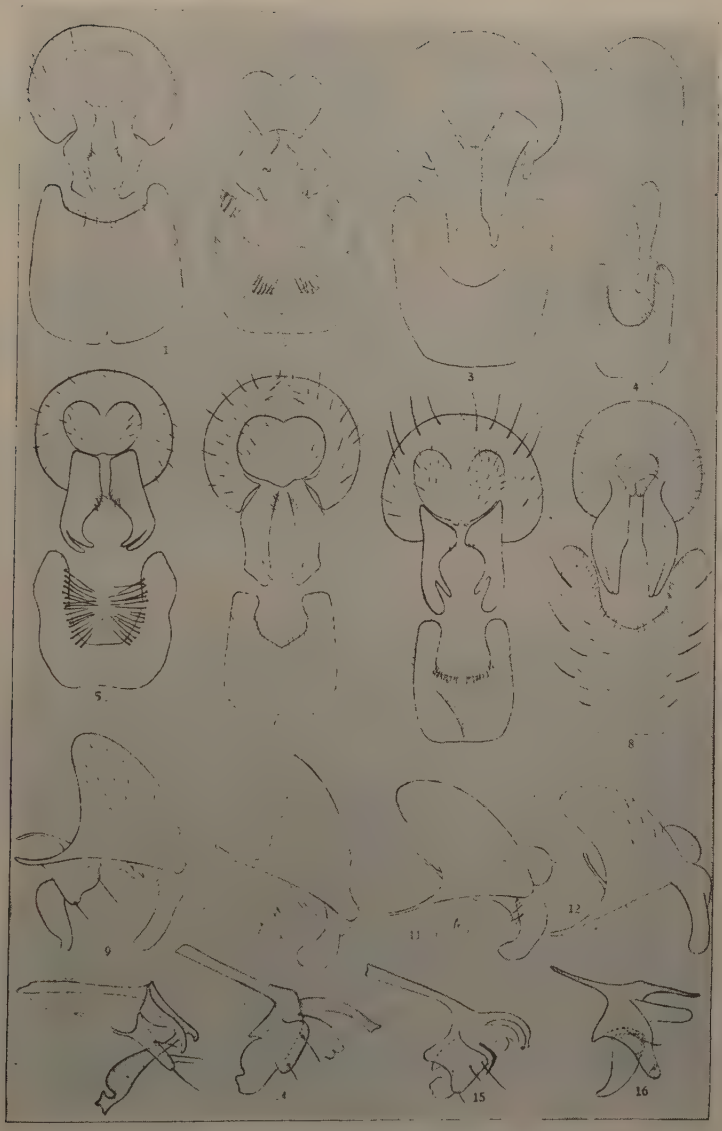
MINES OF SOME DIPTERA

1, Mines of *Phytomyza aquilegiae* on *Aquilegia canadensis*; 2, of *Phytomyza plantaginis* on *Plantago major*; 3, of *Agromyza felti* on *Camptosorus rhizophyllus*; 4, of *Agromyza pusilla* on nasturtium; 5, of *Phytomyza lactuca* n. sp. on *Lactuca scariola* var. *integrata*; 6, of *Phytomyza albiceps* on *Aster paniculatus*; 7, of *Agromyza fragariae* on *Rubus* sp.



EGGS AND MINES OF SOME LEAF-MINING DIPTERA

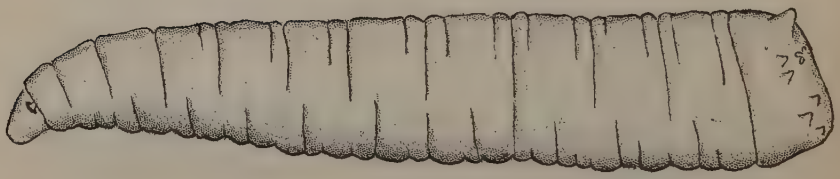
1, Beginning of mine of *Pegomyia calyptrata* (× 20)
2, Eggs of *Pegomyia vanduzeei*; 3, of *Pegomyia hyoscyami*; 4, of *Hylemyia fugax*; 5, of *Pegomyia hyoscyami*, showing typical arrangement; 6, eggs of *Pegomyia hyoscyami* attacked by parasites; 7, eggs of *Pegomyia calyptrata*
8, Beginning of mine of *Pegomyia calyptrata* on *Rumex crispus* (× 30)



MALE GENITALIA OF SPECIES OF PEGOMYIA

1, 11, Male genitalia of *Pegomyia winthemi*; 2, 10, of *P. vanduzeei*; 3, 14, of *P. hyoscyami*; 4, of *P. luteola*; 5, 12, 16, of *P. calyptrata*; 6, 15, of *P. fuscofasciata*; 7, 13, of *P. bicolor*; 8, 9, of *P. unicolor*

1



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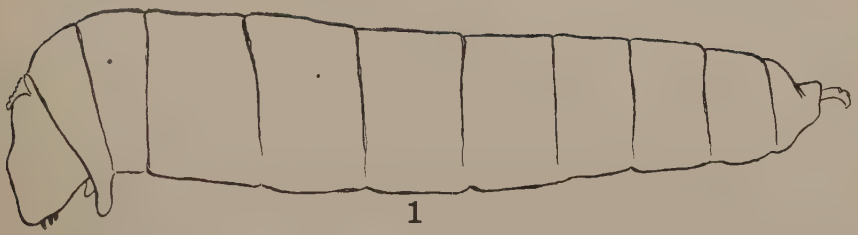
4

LARVAE OF SOME LEAF-MINING DIPTERA

1, Larva of *Pegomyia calyptrata*; 2, of *Pegomyia hyoscyami*; 3, of *Hylemyia fugax*; 4, of *Acidia heraclei*



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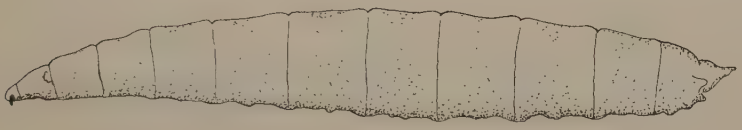

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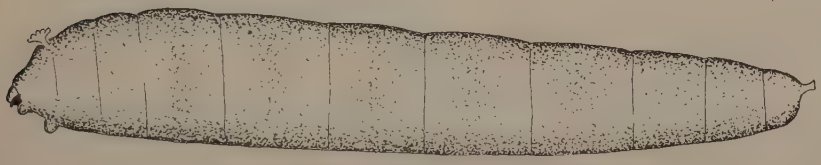

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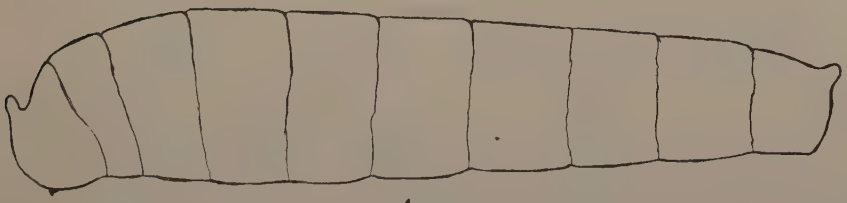

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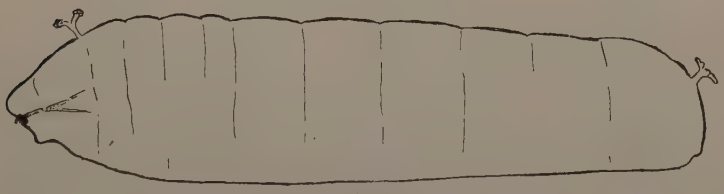
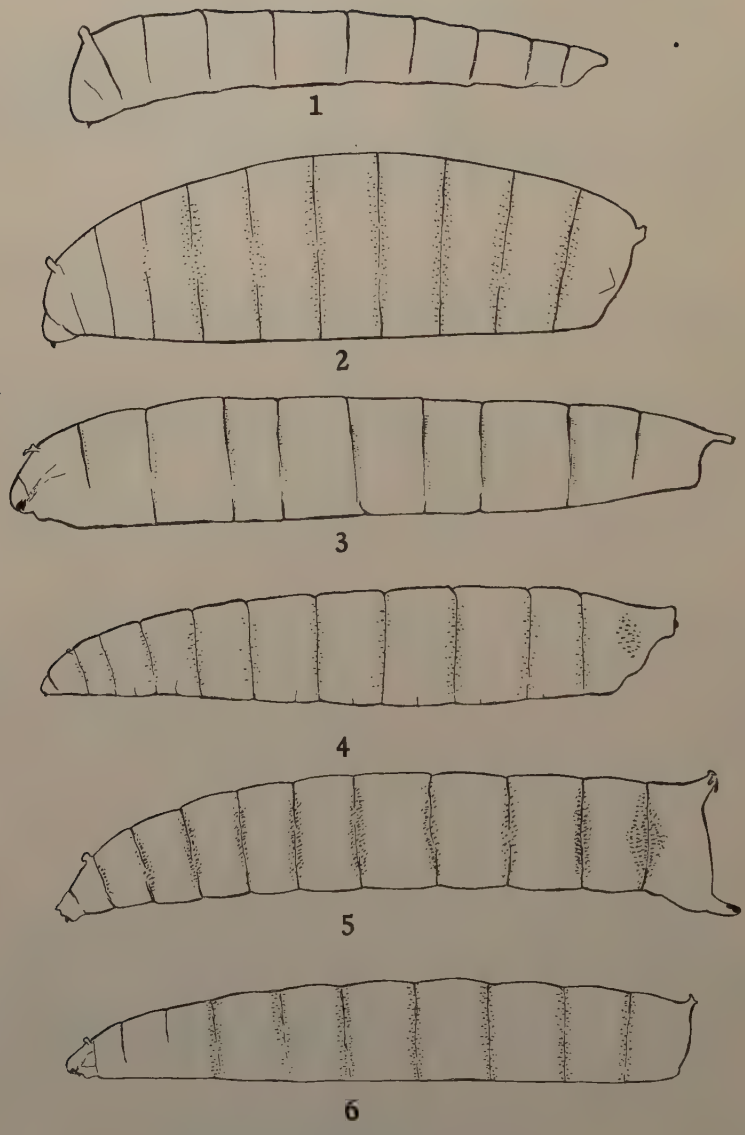


5

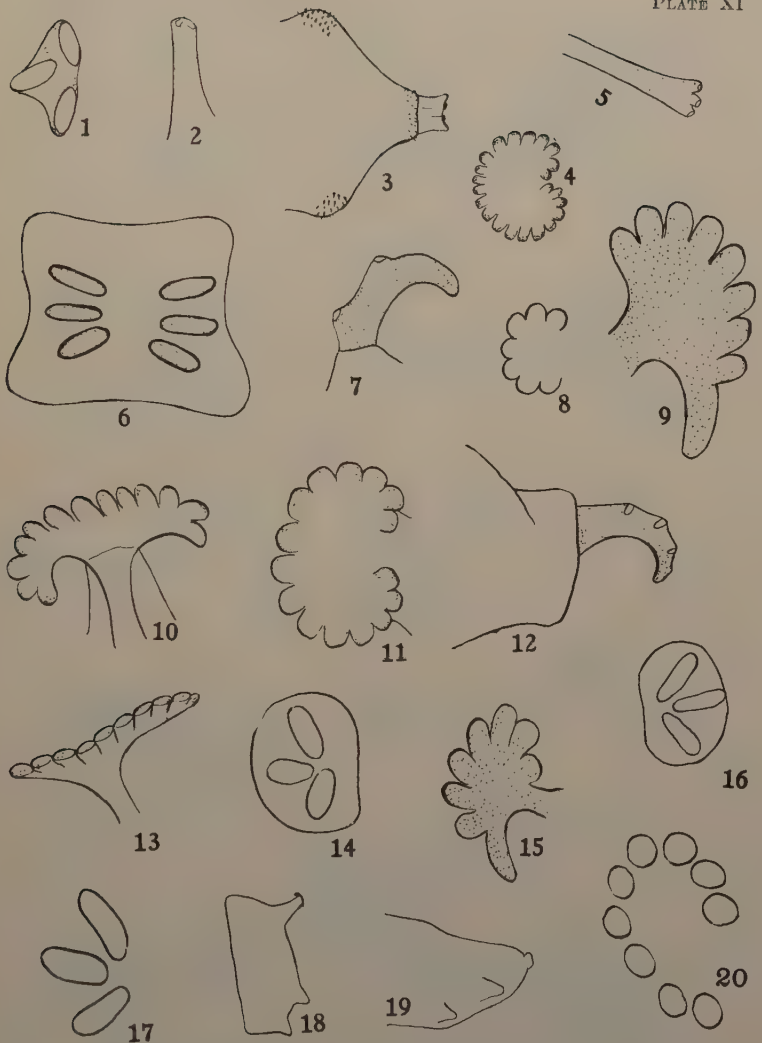
LARVAE OF SOME LEAF-MINING DIPTERA

1, Larva of an undetermined species found on *Cyperus acuminatus*; 2, of *Scaptomyza adusta*; 3, of *Ccrodonta femoralis*; 4, of *Phytomyza chrysanthemi*; 5, of *Phytomyza obscurella* var. *nigritella*



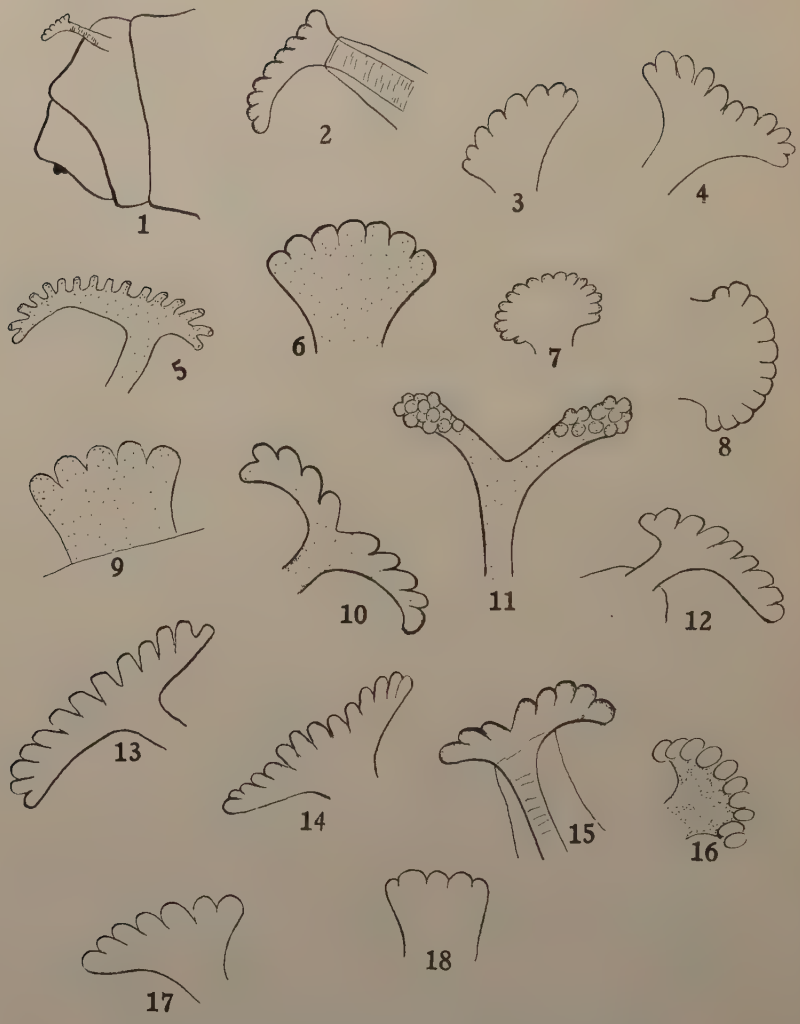
LARVAE OF SOME SPECIES OF AGROMYZA

1, Larva of *Agromyza fragariae*: 2, of *A. melampyga*; 3, of *A. laterella*; 4, of *A. reptans* var. *subnigripes*; 5, of *A. allecta*; 6, of *A. platyptera* var. *coronata*



POSTERIOR SPIRACLES IN SOME LEAF-MINING DIPTERA

1, 2, Posterior spiracles in *Agromyza posticata* (1 showing the radiating stigmatal slits); 3, 6, in *Agromyza reptans* var. *subnigripes* (6 showing the subparallel stigmatal slits); 4, in *Phytomyza ilicicola*; 5, in *Agromyza laterella*; 7, in *Agromyza borealis*; 8, in *Phytomyza plantaginis*; 9, in *Agromyza melampyga*; 10, in an undetermined species found on *Mitella diphylla*; 11, in an undetermined species found on *Solidago* sp.; 12, in an undetermined species found on *Cyperus acuminatus*; 13, in *Phytomyza obscurella* var. *nigritella*; 14, in an undetermined species found on *Hystrix patula*; 15, in *Agromyza pusilla*; 16, 19, in *Agromyza parvicornis*; 17, in an undetermined species found on *Smilacina racemosa*; 18, in *Agromyza ulmi* n. sp.; 20, in *Napomyza lateralis*



ANTERIOR SPIRACLES IN SOME LEAF-MINING DIPTERA

1, 2, Anterior spiracles in *Agromyza posticata*; 3, in *Agromyza fragariae*; 4, in *Agromyza curvipalpis*; 5, in *Agromyza latcrella*; 6, in *Agromyza melampyga*; 7, in *Agromyza borealis*; 8, in *Agromyza allecta*; 9, in *Scaptomyza adusta*; 10, in *Phytomyza albiceps*; 11, in *Phytomyza obscurella* var. *nigritella*; 12, in *Phytomyza ilicicola*; 13, in an undetermined species found on *Cyperus acuminatus*; 14, in an undetermined species found on *Smilacina racemosa*; 15, in an undetermined species found on *Mitella diphulla*; 16, in an undetermined species found on *Hystrix patula*; 17, in an undetermined species found on *Solidago* sp.; 18, in *Phytomyza plantaginis*

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1, Mandibular sclerite in *Agromyza laterella*; 2, in *Agromyza reptans* var. *subnigripes*; 3, in *Phytomyza obscurella* var. *nigritella*; 4, in *Agromyza melampyga*; 5, in an undetermined species found on *Cyperus acuminatus*; 6, in *Agromyza fragariae*; 7, in *Phytomyza plantaginis*; 8, in *Agromyza posticata*; 9, in *Agromyza coronata*; 10, in *Napomyza lateralis*; 11, in an undetermined species found on *Hystrix patula*; 12, in *Hylemyia fugax*, third instar; 13, same, fourth instar; 14, in *Phytomyza ilicicola*; 15, in *Pegomyia vanduzeei*; 16, in *Pegomyia calyptrata*; 17, in *Pegomyia hyoscyami*

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